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ABSTRACT

The theme of the 31st Conference of the International Association for the Development of Computer-Based Instructional Systems (ADCIS) was "Creativity through Analogy." This collection of conference presentations contains 66 papers and 131 abstracts for which there are no formal papers. The papers and abstracts are presented in two separate sections, but both are categorized by special interest group: (1) Academic Computing (SIGAC, 1 paper, 9 abstracts); (2) Computer-Based Training (CBT, 4 papers, 17 abstracts); (3) Elementary, Secondary, Junior College Educators (ELSECJC, 3 papers, 12 abstracts); (4) Emerging Technologies (ETSIG, 10 papers, 13 abstracts); (5) Educators of the Handicapped (SIGHAN, 1 paper); (6) Health Education (HESIG, 5 papers, 4 abstracts); (7) Home Economics Consortium (HOMEC, 5 papers, 7 abstracts); (8) Management Issues (MISIG, 3 papers, 3 abstracts); (9) PILOT Users Group (PILOT, 8 abstracts); (10) PLATO Users Group (PUG, 2 papers, 4 abstracts); (11) Interactive Video-Audio (SIGIVA, 7 papers, 26 abstracts); (12) Theory and Research (SIGTAR, 24 papers, 25 abstracts); and (13) Telecommunications (TELESIG, 1 paper, 3 abstracts). Many of the papers include abstracts and/or references, and an author index covering both sections is provided. (DB)

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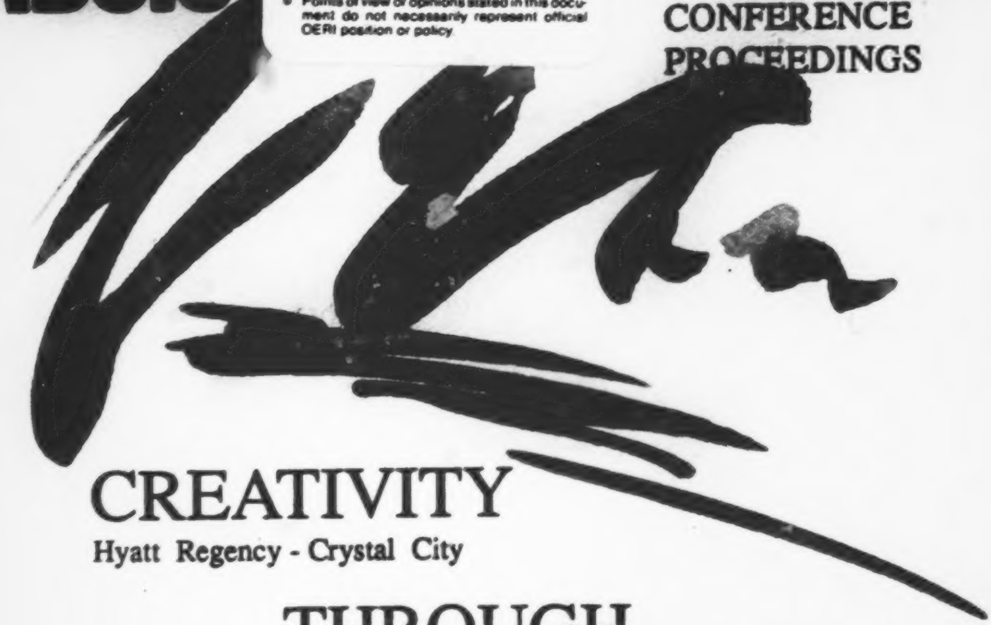

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# PRESIDENT'S MESSAGE

## Proceedings of the 31st International ADCIS Conference

> *"The Human mind . . . operates by association. With one item in its grasp, it snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain . . . the speed of action, the intricacy of the trails, the detail of the mental pictures, is awe-inspiring beyond all else in nature. Man cannot hope fully to duplicate this mental process artificially, but he certainly ought to be able to learn from it."*

**Vannevar Bush**
**American Electrical Engineer**
**(1945)**

If this was"the best of all possible worlds," ADCIS would be presenting you with an electronic version of these proceedings, a "HyperMedia" file which would support and extend the powerful associative powers of your mind. But alas, a lack of resources prohibits this, and you must rely upon your reading abilities and your existing knowledge to "process" this volume in traditional ways. Fortunately, it does include a wealth of new knowledge to enrich that "intricate web of trails" so eloquently described by Vannevar Bush.

The theme of the 31st International ADCIS Conference is "Creativity through Analogy." Within these pages, you should find opportunities and ideas to help you release some of your untapped resources for innovation. You may be tempted to read only those papers specificially related to your interests, but research indicates that an effective means of increasing creativity is to look for ideas in areas outside of your own. Take this opportunity to explore the world of computer-based instruction from new perspectives.

You should also feel encouraged to enter into dialogues with the authors of these papers. Surely, you won't agree with everything you read. Challenge these new ideas if you feel so moved! At the same time, don't hesitate to support and extend the work of your peers however you can. ADCIS as a professional association and this volume as a research and development report will only be worthwhile if you make proactive use of them as resources. And if you have an idea about how to make this a "HyperMedia" volume next year, call me.

**Tom Reeves**
**ADCIS President**

ADCIS gratefully acknowledges the cooperation of Western Washington University Art Department in the design
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This year's cover was done by Brian Grigsby under the direction of Medge Gleeson.

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# Toward Sustainable Improvements in Accessibility and Quality: The College of the 1990s

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The Annenberg/CPB Project[1]

## Abstract

Will our academic applications of the technologies of the 1980s survive and become fundamental to the organization of the College of the 1990s?

One possibility: these technologies may help colleges rework their offerings and facilities in a way that can both bring in new students and also enrich learning for all students. Computing, video and networking can help to increase the reach and richness of four fundamental types of interaction by the student--

a) study with disciplinary tools and resources;
b) study of instructional messages and materials;
c) conversations that occur without interruption; and
c) conversational exchanges that unfold in steps over hours and weeks

This paper suggests how computing, video and telecommunications might be used to renovate facilities and revise courses in a successful College of the 1990s.

## Introduction

We all have seen innovations bloom, then wither and die. They may succeed in reaching educational goals. But if they do not also attract continuing support for their staff, support for their equipment, and support for upgrading content, then it's "lights out." That's not the way for technologies to evolve into a key role in the College of the 1990s.

How might an academic program use technology such that the program, its staff, and its hardware and software budgets survive and grow?

## Accessibility Vs. Quality

Let's start by considering the two most basic goals for improvements: improving accessibility (who can learn) and quality (what they learn). Which goal is more likely to provoke applications of technology that survive (along with their innovators)?

- Improve quality? Faculty are not sufficiently rewarded for improving teaching, whether they use technologies or not. Of course colleges usually are not rewarded in cash or enrollments for more productive learning. Even successful innovations rarely draw a continuing flow of extra funds or tenure positions to divide among the deserving. Not a good portent for innovations that aim "merely" to improve quality. (For related analysis, see Levine, 1976)

- Improve accessibility? Growing enrollments can sometimes augment a program's income and standing. However, many observers assume that new students will stretch resources too thin, and corrupt academic standards in the bargain. So attempts "merely" to open a program to new students are often politically suspect and unstable.

- Implement a programmatic improvement that both brings in new students, while enriching learning for all students. Sounds impossible, but, if it could be done, such a strategy might lack the political vunerability of accessibility-at-any-price strategies, while gaining rewards due to both kinds of improvement.

Money and politics are not welcome subjects in academe. But they cannot be ignored. Hardware is expensive. And the work that faculty put in to develop new curricula is probably even more expensive.

So if we want our applications of technology to grow, we need to worry about where our next meal is coming from. Perhaps we should desigh a strategy that might simultaneously increase enrollment while also enriching all students' learning.

## What Kinds of Students?

What might such a strategy look like? Let's begin by specifying what kinds of students we would like to include in that "increased enrollment."

Let's look at people who have been hindered in their pursuit of a baccalaureate degree by reasons of

- time,
- cost, and/or
- lack of access to specialized instructional resources.

These folks are often older, often have have full or part-time jobs. The majority are close enough to a campus to get to at least some classes. But many cannot register for full-time study. Many have problems meeting with other students or using college facilities outside the specific hours of class. Millions of current students are in this fix. A few million others might also register for college work if courses and services were truly accessible.

One thing to remember about these, and all, students: their time is valuable, and scarce. Faculty often assume that students can spend as much time as they please on a course (including travel time and other time not directly related to learning). Not so. (See, for example, Beeman et.al., 1988)

If this many students are to get a new level of educational service, then whole colleges need to adapt in order to provide it. So the remainder of this essay will consider the "College of the 1990s." Because it takes us 5-10 years to learn to use any new technology on its own terms, let us make a radical assumption. Assume that the core practices of the College of the 1990s will be based on technological capabilities already present in the 1980s...

Since these students are sometimes separated from their teachers and their intructional materials, the next step is to ask, "If students are to engage in the higher learning, what must happen across that set of separations? How do students need to interact with the materials and people involved in their learning?"

## Two Pairs of Interactions

Academic programs employ old and new "technologies"[2] in order to help students engage in two pairs of interactions. We'll describe the iteractions here in their traditional forms, and then describe how each is taking advantage of new technologies.

1. Study with messages and physical objects that are sent one-way from one developer or teacher to many students. After this "broadcast," the student interacts with the messages and objects by studying them, or studying with them. This pair of interactions includes:

a) Study with tools and resources in order to work on the open-ended problems of the field. Traditional disciplinary tools include typewriters and science laboratories. Resources range from novels to fieldwork sites. The student is given either industrial-strength tools and and resources ( e.g., a real typewriter, a real novel) or realistic student versions (e.g., shorter skiis in a skiing class).

b) Study of instructive messages and materials about the field under study. Traditional technologies for broadcasting such messages include lecture halls and textbooks.

Broadcasting messages, materials, tools and resources is economically attractive because there are economies of scale: admitting one more student to the lecture or the library doesn't cost very much.

Study is interactive insofar as the student carries a critical, internal conversation with the possibilities of the materials. "What did the lecturer mean by that?" "Does it make more sense if I look at it from this point of view?"

2. Two-way conversations and exchanges with faculty, peers and distant experts:

a) Conversations with others in "real-time" (i.e., synchronously --occurring seamlessly over a period of seconds or minutes). Traditional technologies for supporting fast-paced conversations include the seminar's circle of chairs, the faculty office, and the dormitory corridor.

b) Time-delayed conversation. Take homework, for example. That conversation between faculty and students develops over a period of days. Participants take part from a variety of locations and at different times. The key traditional technology for making homework into a conversation is the campus itself. It may seem odd to think of the campus as a "technology," but it supports time-delayed conversation(and all three other interactions) by bringing people and resources close together. That way they can exchange ideas and things quickly.

Compared to the economics of broadcasting messages and materials, the economics of interpersonal conversations are very attractive, at least if one assumes that the teacher needs to be at the center of each conversation. Visions of quality that depend on small classes are expensive.

Think of these four types of interactions as the table legs which support the learning environment (See fig.1).

**Learning Environment as Tabletop**

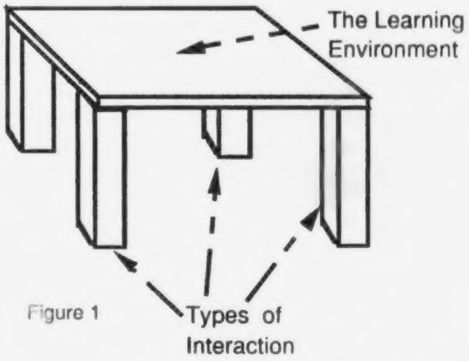


Figure 1

## How do Colleges Usually Improve Accessibility and Quality?

Pursuing economies of scale, colleges often try to improve accessibility by more efficiently broadcasting instructional messages(e.g., larger lectures, computer assisted, instruction (CAI)distributed on inexpensive diskettes to many students, telecourses broadcast to distant learners). They try to improve quality by improving the quality of the instructional messages (better lecturers, better texts,etc.) It is easy to downplay the other three types of interaction, perhaps because, with the older technologies, they seem more expensive to support. In theory, doing a better job of broadcasting tools and resources might seem sensible. But there are several problems with that: a) without increased interpersonal support, students are likely to flounder even with better tools, and b) traditional tools are often expensive and specialized.

But without adequate tools or conversations, the broadcast instruction has to be stretched to cover the gaps: anticipating student questions, and offering vicarious experience in what tools and resources can do (See figure 2). Also, developing materials that anticipate student questions and misunderstandings is expensive to do well. It's even worse with our students, who are older and more varied in background. And vicarious experience is--just vicarious: one can't learn to ride a bicycle only by watching someone else do it

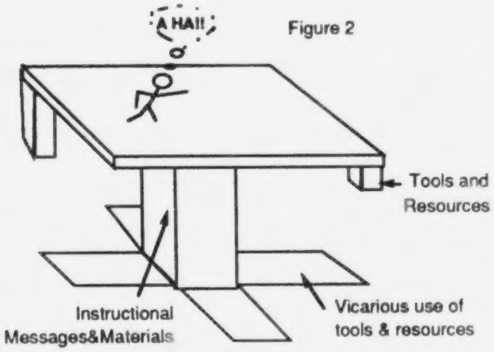


Figure 2
A HA!!
Tools and Resources
Instructional Messages&Materials
Vicarious use of tools & resources

So the question becomes: can colleges use the technologies of the 1980s to support all four kinds of interaction, enriching each as it lengthens its "reach"?

## Stretching and Strengthening the Four Interactions

Computing, video, telecommunications and/or other old and new technologies can be used to stretch and strengthen each of these four interactions. Moreover, much of the relevant hardware and software can be used by many students and faculty in many courses.

Equipment isn't free, so the students and faculty in the College of the 1990s will use it in three settings:

a) on the contiguous campus: in classrooms, libraries, laboratories; computer clusters and other equipped study sites in academic buildings and dormitories. Dormitories? Even students living on campus have jobs and tight schedules; they too can benefit when technology enables them to spend their time more productively;

b) "outreach sites" at mini-campuses in the neighbourhoods, businesses, public schools (where teachers, high school students, and community members may want college credit), other campuses (a new wrinkle in cross-registeration programs[3].), and libraries. Each site will house the kinds of technologies that we will discuss below.

c) homes and other sites not equipped by the college where students may use their own computers, modems, telephones and VCRs.

Let's work through the four types of interaction again, outlining the technologies a college might use to offer a wide range of courses. Remember that the goal is to increase net enrollment while also improving the richness of learning. To flesh each section out, we'll describe how each interaction might be supported for a variety of learners taking a second-year French course.

As we discuss each of the four interactions, we'll come across several themes repeatedly:

- A style of teaching that exploits some combination of individual and small group work using realistic tools and resources.
- Instructional messages sometimes developed in advance for use when and where the student chooses.
- Lots of conversation (much of it time-delayed) with other students, outside experts, and the faculty member.

### 1. Tools and Resources for Problem Solving

When video and computing first made their appearances, everyone assumed that their most powerful and popular use would be for direct instruction. Instead word processing, spreadsheets, data bases and other commonly used software are becoming the everyday tools for carrying out the fundamental activities of thought:

writing, calculating, organizing information. The use of video as a storehouse of visual resources (artwork, scientific imaging) is growing rapidly, too. With the arrival of optical discs and increased networking, technologies are bringing libraries to the fingertips of students. The University of Illinois, for example, has enabled students to log on from any computer with a modem, search any library in the system to find out which of the current holdings are on the shelf, and then to have the needed reference sent to them.

This trend has potent teaching advantages. Students can work on realistic problems with realistic tools; in consequence, they may work longer and smarter. (e.g., Beeman, 1988;Lewis, 1989) Because computer-based projects are easier to revise, students are more able to rethink and redo their work, perhaps learning more the second time around. (See FIPSE Technology Study Group, 1988: 16-18)

Most faculty are unlikely to change their teaching to take systematic advantage of these capabilities unless all students can use computers. So many colleges are already taking steps to assure access through some combination of student-owned machines, institution-owned machines, and other arrangements (e.g., loaning or leasing equipemnt). The study sites of the College of the 1990s will be equipped with mixes of machines. All sites will support basic tools and resoures, including access to libraries and data bases; some will have more specialized tools and resources.

How might French II be taught with such resources? Today many faculty wish to teach French as a means of expression within a culture. A faculty member might prepare a number of assignments which students would carry out, individually or in groups, by studying French television programs and accompanying print drawn from the PICS[4,5] collection. Different students will balance their work time differently: between campus, outreach sites, and homes. Campus and outreach sites will offer specialized equipment such as videodisc players. Students could analyze French video stored on PICS videodiscs (readily rerunning a sentence as many times as they want to watch and hear it, for example). Or they might use an interactive documentary disc produced by MIT whose video was taped in a French neighborhood.[6] The same VCRs and videodisc players could be used by many other courses using the same study sites.

The French faculty also wants students to learn to write French and not just speak it, so our students employ word processing, perhaps using Systéme D software[7], which offers a variety of online references about the language and its usage.

Prices for video and software have fallen. Some of the sites can offer small libraries of video materials and software, (especially if the technology allows both large classes and rich interaction of all four types). The students who can take advantage of off--campus sites also save the cost of travel and time. The campus can afford to offer some equipment because many students will buy and use their own; it is general purpose equipment whose cost can be justified by a variety of personal and professional uses. (For a more detailed argument for developing curricula that relies on commonly available hardware and software, see FIPSE Technology Study Group, 1988: Chaper 2).

## 2. Instructive Messages and Materials

Many faculty invest much of their student time into live lectures that students receive as though they were prerecorded broadcasts. Nothing wrong with that. But in our tabletop model, students are also asked to learn by working on problems that can fight back. Here the student needs coaching and critique. Providing these, or arranging for them, takes faculty time, too. A logical place to find time is to reduce the time spent repeating last semester's lectures. Is it even wise to ask adults to find common time to sit in a large room silently listening to a lecture that they can't even "pause" and rewind?

It makes sense to consider audiotape, videotape, and software to complement or replace live lectures. Of particular import are new technologies for desktop publishing and presentation. Instruction can be "packaged" in pieces for student use at times, places and paces of their own choosing.

When the student can get an outreach site, for example, she might find tapes, computer-assisted instruction, or a set of written lectures on diskette, all indexed by topics. Some sites might even be connected to a central library of tapes and software through a broadband network, so that the student can download material. Here too the student saves time from travel and spends it on learning. Some of the materials would be used at the site, while others might be copied for use at home.

For our French example, the class might use all or part of the video, audio and print from the French in Action telecourse. The possibilities of computer-assisted instruction range from drill and practice programs all the way to high powered software that could teach conversational skills, ear training, and "native" accents.[8]

### An Interruption to Talk About The Second Pair of Interactions: The Conversations

Why does this model award conversation two legs of the tabletop?

First, conversation can support almost any kind of learning. Student interaction with other people, particularly peers, can make teaching more engaging and effective (through collaborative work on projects, coaching, social support, and brainstorming, for example.)

Important as that goal for conversation is, there is an even more fundamental reason to support it--the values and skills inherent in a productive conversation are goals of higher education:

a) Education is an initiation into the disciplines, and disciplines are intellectual communities that define knowledge collectively. A discipline's concepts, procedures and values come to be known and validated through debate and interpersonal interaction.

b) Almost every profession and occupation requires people to perform often as members of a team, and to be rewarded for their team's performance.

c) One purpose of organized liberal education is to promote the intellectual life and cohesion of our communities. Perhaps that's one reason why we ask alumni and governments to contribute, rather than relying solely on a student's tuition (which might be justified if the only beneficiary of liberal education was the learner.)

However, colleges tend to isolate learners, rather than teaching them how to build and take part in productive communities and teams. Ironically, some observers have feared technology as isolating. On the contary, a major promise of new technologies is to help us break the barriers of isolation, and help us revitalize our college communities.

### 3. Time-Delayed Conversation

Technology's first Big Surprise for colleges was probably the rapid spread of word processing and other tools and resources. The second may be a rapid shift from real-time conversation toward time-delayed conversation in the 1990s (E mail, fax, and their cousins).

The traditional college offers two conversational tempos--the bangbang of the seminar, and the week's delay of homework exchange. Not much in between. Time-delayed (asynchronous) telecommunications offers a conversational rhythm that can range from hours to a day or two.

The exchange of homework ought to be conversation productive of learning but it often isn't. The reason is partly in the tempo of the traditional technologies of exchange--it simply takes a long time to move homework from one spot to another and a long time to assess it. Another reason is that the typical homework cycle requires that the instructor be one half of every conversation. Computer-mediated communications can help. Electronic messages move virtually instaneously, and computer conferencing tends to favor collaborative interaction. As the tempo of exchange accelerates, and students are asked to converse with other students, the time-delayed conversations become more productive.

Just as there are advantages in speeding up homework exchange, so too there are advantages slowing down the seminar. The reasons aren't hard to figure out. Just ask someone why they are using electronic mail rather than the telephone: "slower can be better." The classroom abhors awkward silences, so exchange needs to be quick: sometimes too quick for thinking, or too quick for some students to leap into the conversational rapids. With a conferencing system, each participant can take seconds, or hours, to devise a deft and telling contribution. One group that gains special benefits: students and teachers whos oral English isn't the best.

So our College of the 1990s ought to make adequate provision for faculty and students to participate in the exchange of projects and conversation. Study sites ought to be equipped for time-delayed conversation. Appropriate technologies include file exchange, electronic mail, computer conferencing, and fax.

Some colleges will take advantage of another technology of the late 1980s--

hypertext that can support rich branching conversations. Brown University's new Intermedia system[9] allows conversational comments to be linked to the texts, images, and small databases that are the objects of the class's conversation. Since conversational contributions can also be texts, images, and small databases, the "talk" and "what is talked about" can be woven into single intellectual structure, like the chains of DNA.

How could our French teacher use the college's new facilities? Students could write to one another in French on a variety of topics, only some of which pertains to class. Some of the exchanges might be with people off campus, even as far off as French-speaking countries. This kind of teaching has already begun. Professor Karen Smith of the University of Arizona[10] has organized Spanish courses along these lines. Students praise the system because of its accessibility (they can do home work day or night, from a variety of locations) and because they are really using their Spanish. They also can communicate without always being self-concious about their speed or accent. Working more slowly, they can explore new modes of expression. To Smith's surprise, even oral performance in class has improved, since students can first try out more ambitious thoughts and constructions within the slower paced conversation.

## 4. Conversation in Real-Time

Busy students have only limited opportunities to meet at the same time, let alone in the same place. Those valuable meetings ought to be rich with uninterrupted (real-time) conversations such as those in seminars and the coaching of perfomances. In our College of the 1990s. most of such conversations will occur in small groups, and with people in the same place (using "groupware" technologies that range from blackboards to local area networks with video switching). And many will occur in real-time among people who are in different locations.
The technologies of the 1980s for supporting real-time conversations at a distance include:

- telephone,
- audio conferencing,
- text-based conferencing (sometimes called "chat"),
- video conferencing (two-way audio; video sometimes one-way, and sometimes two-way), and
- audiographic conferencing.

What is audiographic conferencing?--any system that allows users to both hear each other, and to see a common image on their computer screens. Participants can talk about what they are seeing on screen. To aid the conversation, they can also point with a cursor, draw, and type. In some systems, they can even work on writing a paper, a computer program or spreadsheet together. The Annenberg/CPB Project has sponsored studies of audiographic conferencing and also the development of calculus course materials for such a system (see Gilcher and Johnstone, 1989).

The College of the 1990s will equip its sites for audiographic or videoconferencing; the homely telephone will become even more useful as the importance of conversation increases.

Students in our French course could use audiographic conferencing to discuss and annotate the video images of France. At Harvard University, Prof. Marlies Mueller has been experimenting with the use of audiographic conferencing with the video from the telecourse French in Action.

Our French students also need to learn by expressing themselves in writing, and they can write in real time by "chatting" over a computer network. The technique is called Electronic Networking For Interaction (ENFI), and the software can be quite sophisticated. In an ENFI class, students must write in order to be understood. The live dialogue scrolls up each students screen and is saved to disk. Its advantage over oral discussion is its somewhat different pace. Conversational writing provides a bridge that can be used to build skills of more formal writing. (e.g., Thompson, 1988) Perhaps its greatest value--students see that writing is a way of making themselves understood to peers, not just an exercise to get a grade.[11]

## The 1990s: The College...

By now it should be apparent our quest for reach and richness has resulted in a redefinition of some familiar terms.

"Accessibility" traditionally means "giving excluded students a fraction of what 'normal' students already have." The new "accessibility" means "extending the reach of all students and faculty, which makes it possible for new students to participate as equals."

"Quality improvement" has meant "doing better what you've been doing, and spending more to do so." The College of the 1990s is reexamining its goals, too, and giving more emphasis to educating individuals in creative and analytic skills, as individuals and as members of teams and communities. And it's clear that these quality improvements have to be done in a cost-conscious and income-conscious way.

Further we can see that "accessibility" and "quality" are intimately interlaced. The walls of the "classroom" are lowered so people can reach out as well as in. For example, they will use networks to communicate with distant people and resources. "Academic community" can be revitalized, but "campus community" will become an oxymoron--the community will not be constrained by the streets edging the campus.

A variety of interest groups are moving us toward a more open conversation of learning--groups should become accustomed to working together:

- Faculty who depend on electronic networking with their peers around the world.
- Pioneering distance learning programs using satellites, computer networks, fibre and anything else they can lay their hands on to enrich their connections with their students.
- Faculty and academic computing specialists taking increasing advantage of campus computing "clusters," adding new equipment, new networks, and new functions to these rooms.
- Colleges that are developing ways to teach classes to students at two or more branch campuses.

What's remarkable is that these varied groups all share an interest in implementing about the same package of technologies in pretty much the same places.

## ...And The Course

The other happy parallel is the lengthy list of similarities between the curricular improvements being made by faculty in a variety of disciplines--with a variety of teaching styles--once they and their students get their hands on these technologies. (see, e.g., Ehrmann and Balestri, 1987; FIPSE Technology Study Group, 1988; Lewis, 1989)

Faculty have to consider many factors in rethinking their courses, e.g., how much to develop the materials and assignments that will help their students learn in groups (see Bouton and Garth, 1983).

One of the most interesting aspects of course revision is the content itself.

Here are four important goals to consider when rethinking content:

1. **Help the students learn how to pose interesting Problems, make progress on them through Problem-solving, and then check on that progress through debate and Persuasion (what John Jungck and Nils Peterson have termed the "3Ps" in Peterson and Jungck,1988) These "3Ps" can help guide our use of technologies such as hypertexts, open-ended simulations, and video libraries, all of which enlarge the intellectual "tabletop" that the student can explore.**

2. **Add new ways to visualize ideas and phenomena, and give students more freedom to change the ways that ideas are represented (e.g., software that allows the student to see an equation as symbols or as a graph)**

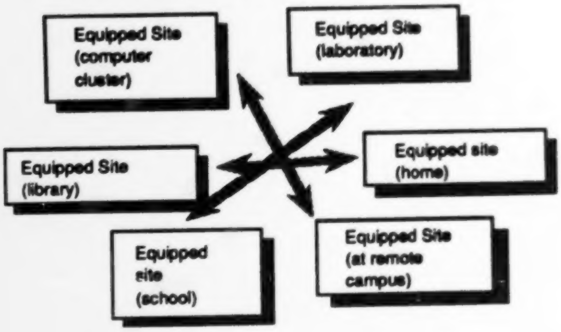
3. **Since specialized software and video can be expensive, it may be wise to focus them on opening instructional bottlenecks--topics and skills that students ordinarily learn well enough to pass an immediate test, but not well enough to help them learn in other courses. Classic examples: the deeper meaning of concepts such as "function" and "structure" (in any discipline you choose.) Courseware that can help open such a bottleneck is more likely to pay for itself in the long run.** (FIPSE Technology Study Group, 1988: 24-25)

4. **Attend to more than just physical accessibility. Our world is becoming incredibly multi-cultural and diverse. The students who come to our universities can be well-served by offering them more challenging assignments in a more supportive environment.** (See, e.g., Watkins, 1989). But that kind of access won't happen by accident. At the college and course level, there needs to be serious consideration of the needs of the cultural minorities (everyone) and how and when to tie instruction to their communities. (FIPSE Technology..., 1988: 49-59).

Put this whole argument together, and you have figure 3: by stretching and strengthening the four types of interaction , colleges can engage and support students so well that they can gradually take greater responsibility for their own learning. As students take more of the load of teaching and learning ( working in groups, for example, under faculty supervision) the institution can handle the larger numbers of students that the technologies can now reach.

See Figure III

The College of the 1990s? Figure 3


Equipped Site (computer cluster)
Equipped Site (laboratory)
Equipped Site (library)
Equipped site (home)
Equipped site (school)
Equipped Site (at remote campus)

## The Open Questions

This essay has confidently implied that the College of the 1990s can be created in this manner, and affordably, using the technology of the 1980s. Is this true?

I don't know.

It does seem possible, despite the need for additions to the working capital of students and faculty. One encouraging note: the cost of the equipment and its maintenance can be shared by a variety of sources, inside and outside the college. For example, suppose neighboring schools transform several classrooms into electronic "branch campuses" which deliver continuing education to teachers as well as college-credit education to students and adults in the area. Such a network could also let schools share teachers at a distance. Colleges, schools, and the government would probably share the cost of creating such a network.

Attempts to use technologies to help academic programs evolve in this way will certainly be risky. But less ambitious efforts can fail when they are not structured to attract the resources they need for continued survival and growth. The most attractive feature of this vision is the chance that it may work.

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# INSTRUCTIONAL DESIGN AND ARTIFICIAL INTELLIGENCE:

## REDEFINING THE ROLE OF THE CBT COURSEWRITER

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### Abstract

The Automatic Courseware Expert (ACE) System introduces an entirely new concept into Instructional Design of Computer Based Training (CBT), by harnessing Artificial Intelligence (AI) to design the course. ACE is used by the coursewriter as a workstation, just as an engineer uses a CAE workstation for design. The writer can prepare all phases of the course-planning, design, development - at the workstation. Since ACE programs the course automatically, no programming is required, thus reducing the dependence of the coursewriter on programmers.

In effect, ACE changes the role of the coursewriter since the relationship between the coursewriter and ACE is very different from the relationship between the coursewriter and conventional authoring systems. Whereas an authoring system is only a productivity program, ACE serves as the coursewriter's assistant. ACE allows the coursewriter to become more flexible when making instructional decisions and makes it easier for the coursewriter to prepare CBT for the various options. The coursewriter can change the direction of a course at any stage of the development process, and can experiment with different approaches without having to completely rewrite the course.

ACE relieves coursewriters from repetitious time-consuming tasks, giving them more time to spend on planning the course and improving its quality.

This paper describes the ACE system, and explores the way in which ACE can enrich the role of the coursewriter.

### ACE - Description

ACE is an integrated workstation that introduces an unprecedented high level of automation into development and production of CBT tutorials. ACE consists of a super-mini computer for AI applications for course design and screen layout, and a special input/output computer which inputs examples, simulations and graphics, and generates CBT courseware directly onto diskettes. An input video sensor is used for automatically entering screens from the target system for which the tutorial is being prepared, while an optical document scanner is used for automatically entering text drawings and illustrations. The system comes with all the software required for planning, designing, laying out and production of the course. Figure 1 illustrates the different roles of the coursewriter in traditional CBT development and in the ACE approach. The new role of the coursewriter by interacting with ACE is explained in the next section.

### Coursewriter Interaction with ACE

ACE develops courseware at a very rapid pace. It assists the coursewriter in planning the course by accepting guidance as to type of instruction to be implemented by the CBT (e.g. Walkthrough or Exercise).

ACE implements a structured approach as to the acquisition of knowledge regarding the procedure that needs to be taught. Thus, the coursewriter is given tools for formalizing the basic steps and activities involved in the description procedure. This is known as creating a PATH. By means of the PATH, the coursewriter induces the Subject Matter

Expert (SME) to enter more descriptive information concerning various operations, i.e., the Operational Attributes of the procedure to be taught (e.g., Usage, Definition, and Purpose of key operations).

The coursewriter together with the SME select an appropriate operational example to demonstrate the procedure to be taught. The SME runs this demonstration on the TARGET SYSTEM (the actual system which the course is being prepared on). ACE automatically records ("captures") the screens displayed on the Target System and the corresponding keystrokes typed by the SME. ACE also has automatic recording capabilities via a scanner allowing immediate recording of any document. Specially, documentation that can be used as an additional source of information on the subject matter.

**Figure 1: Traditional CBT development vs. the ACE approach**

Figure 1: Traditional CBT development vs. the ACE approach

Figure 1A Traditional CBT development

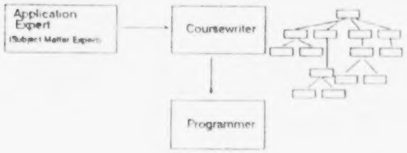
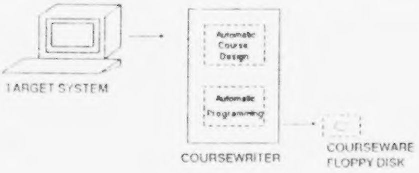


Figure 1B The ACE approach



After completing the entry of information concerning the topic to be taught (text and graphics), the coursewriter selects automatic design. During this process ACE analyses the application described and designs a draft of the course. This DRAFT is described in terms of Courseware Descriptors (CDs) which are the draft instructional components of the course (e.g. Introduction, Review Question, Procedural Steps, etc. ).

The coursewriter has now the option to edit this draft. Content can be added and structure can be changed, for example by the addition of a Pretest CD or the deletion of a Conclusion CD. The coursewriter may also change the content of the Prerequisites at the beginning of the course, or the content of the Farewell message at the end.

Once the course structure and course content have been approved by the coursewriter, ACE automatically designs the course screens which are then also available for modification by the coursewriter. For example, changing the line spacing of the text display on a particular screen (SHOT), or requesting ACE to change window coordinates throughout the course.

Once the screens are satisfactory, ACE automatically programs the output course on to a floppy diskette.

## How the Coursewriter Benefits from ACE

As ACE automatically designs and produces courseware, it can complete several course units in the time it takes an authoring system to design only the screens for a single course.

The high productivity of ACE allows the coursewriter to experiment with various options, e.g. to develop a course prototype which can be presented at a very early stage to the course customers and to training management. The coursewriter can also use the prototype to field experiment with students, and then modify the course to better fit the targeted audience. In other words, the coursewriter has a hitherto unprecedented opportunity to achieve a consensus of what is wanted in the course at the very early stages of course development.

ACE saves the time required for manual entering of simulation screens (displays from the target system), and keeps track of all the information which has been entered for procedure simulation. ACE does not loose information, nor does it record incorrectly. This in turn saves the coursewriter from having to check for accuracy and detail.

ACE's built-in design tools give the coursewriter the flexibility to manually overrule any decision or suggestion made by ACE. In addition, the coursewriter can introduce personal style and idiosyncrasies into the AI-designed screen layout.

Since ACE stores all previous produced courseware in its memory, including their structural and instructional specifications, this enables the coursewriter to reuse previous sections of courses - or even whole units - when preparing a new course. This can save the coursewriter an inordinate amount of time, since definitions (for example) do not need to be inserted each time a similar unit with a different instructional technique or different mastery level is being created.

### The Redefined Role of the Coursewriter

The coursewriter's forte can be directed primarily in the creative domain and in planning aspects of course design. With ACE, the coursewriter is relieved of the time consuming and tedious tasks which so detract from the creativity aspects of coursewriting. In addition, the automatic programming performed by ACE relieves the coursewriter of the traditional dependence on programmers. The coursewriter assumes greater control of the entire process, including the course flow and screen layout programming.

ACE gives the coursewriter more time to spend on analyzing course audience, investigating the instructional implications of the subject matter to be taught, designing the overall course, and deciding how to incorporate the CBT into the stand-up training and printed training material. The selection of simulations and examples to be used in the course, remain the exclusive domain of the coursewriter's judgement and experience. The coursewriter determines the type of scenario which will serve as the main motif of the course (COVER STORY) and decides on the level of explanations and the complexity of the application simulation to be presented in the course.

Interaction with and feedback from students, and communication with external departments as Subject Matter Experts, can only be done by the coursewriter. The time saved by ACE can be diverted by the coursewriter to these important and more productive functions.

### How ACE and the Coursewriter Work Together

The professional coursewriter plans, supervises and evaluates. ACE automatically executes these plans which the coursewriter can then accept or modify. ACE handles details, record keeping, and organization of all the information required for creating a CBT course. The coursewriter needs no longer be involved in these details.

ACE provides the environment for knowledge acquisition from the Subject Matter Expert (graphics interface, recording programs, etc.). The coursewriter determines what knowledge is to be acquired and then easily inserts it into ACE. All the CBT-related information is stored and ready for retrieval at any time. This is an invaluable tool, since the coursewriter can create sets of knowledge for a number of similar courses with standardized course design, retrieving CBT information as needed for each new course.

Finally, ACE takes over the boring and tedious tasks involved in course production. This allows the coursewriter to concentrate on dialoguing with all the people related to the development and approval of the course (outside departments, customers, training management, subject matter experts, etc.).

### Summary

ACE has the potential to greatly improve the effectiveness and status of the coursewriter by acting as an intelligent assistant. ACE frees the coursewriter from tedious tasks and allows full reign to the people-skills and creativity that are the exclusive domain of the coursewriter. Mutually beneficial interaction between ACE and the coursewriter can produce CBT tutorials of a new level of sophistication - and in record time.

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# U-Diagnose Software as an Evaluation Simulation

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Abstract. Simulations that teach differ from those that evaluate. U-Diagnose simulations are created to evaluate an individual's ability to make decisions about a client's situation and intervention plan. The generic design of a U-Diagnose simulation is described using Gredler criteria for classification of computer exercises.

Case studies or situations have been used in education to provide a bridge between textbooks and the world outside of the classroom. "A simulation is a realistic representation (model) of the structure or dynamics of a real thing or process with which the participant, as an active part of the experience, interacts with persons or things in the environment, applies previously learned knowledge to make responses (decisions and actions) to deal with a problem or situation, and receives feedback about responses without having to be concerned about real-life consequences" (de Tornyay & Thompson, 1987, p. 25). The advent of the microcomputer enabled educators to move from pen and paper simulations to computer-based simulations using all the advantages of this technology. However, the underlying design of a simulation needs to be examined before it can be used effectively in an educational setting. Simulations may be used to present information, guide learners, provide practice or assess learning (Alessi and Trollip, 1985). For this paper, an evaluation simulation is defined as a situation test that assesses an individual's ability to make decisions about a client situation.

Diagnostic simulations are one type of simulation. "The diagnostic simulation is one in which the student may select optimum actions, harmful actions, or those that neither facilitate nor impede progress. The optimum set of decisions determined in advance by the programmer is derived from subject area or professional expertise" (Gredler, 1986, p. 9). The U-Diagnose simulations use case studies as evaluation simulations for diagnostic reasoning. The U-Diagnose reasoning simulation is defined as a case study that portrays a realistic clinical encounter that requires the respondent to make decisions about client problems, and formulate an intervention plan.

The following Gredler criteria for classification of computer exercises will be used to describe the U-Diagnose microcomputer software.

1. Nature of the basic situation presented to the student;
2. Use of visuals and data in presentation and feedback; and
3. Nature of the instructional process (Gredler, p. 10).

## NATURE OF THE BASIC SITUATION

According to Gredler, the nature of a diagnostic reasoning situation is a complex real-world problem that takes new directions in response to student input (Gredler, p. 11). The U-Diagnose software begins with a narrative description of a client situation, which is based on actual cases. The user is expected to assume the role of the professional handling the case. The test is divided into two sections. In the first part of the test, the respondent is expected to identify the problems for the situation using data from the scenario.

In the second section, the respondent formulates a plan for handling the major problems. The narrative scenario does represent a situation that requires professional expertise.

## USE OF VISUALS AND DATA IN PRESENTATION AND FEEDBACK

The data for the U-Diagnose test consist of listings of choices for problems, objectives, outcome criteria, interventions and rationale. Thus the text is presented in a tabular format. However, the choices are written according to the professional format and terminology for a given discipline. Although each case study must be written to include the protocols previously described to be compatible with the software, the components of the diagnostic reasoning model are easily adapted to other fields of study. The scenario can be written on any word processing program and transferred to an ASCII file. If a discipline does not require all components, only those that are pertinent need to be used. For example, the problem identification section could be omitted using only the plan section.

Unlike computer-assisted instruction, feedback is not provided within a U-Diagnose simulation. Once a specific evaluation simulation is completed, the respondent receives results in a detailed printout along with an interpretation sheet. Each section is scored numerically and a combined total score is provided. In the problem identification section, each problem and data chosen by the user is listed and labeled as correct or incorrect. The intervention plan section includes a list of choices for major problems and their related objectives, outcome criteria interventions, and rationale. Both the right and wrong choices are identified. Four categories of ratings by the U-Diagnosis software correspond to the choices made for relevant problems, major problems, interventions, and rationale. Each of these categories is classified further based on degree of accuracy of the examinee's responses. Thus, the feedback is a comprehensive description of an individual's reasoning processes for the given simulation.

## Nature of the Instructional Process

The purpose of the diagnostic reasoning evaluation simulations is to determine if the respondent can demonstrate appropriate problem-solving behaviors for the subject matter reflected in the specific simulation. The computer software acts as an evaluator by comparing the respondent's choices with an answer key developed by an expert panel.

The intent of the U-Diagnose computer software is to evaluate diagnostic reasoning using a standardized format. The turnkey design of the evaluation simulation allows for its use within a variety of disciplines.

The Gredler criteria helps the creator to clarify differences between teaching and evaluation simulations. Also it guides the user in determining which type of software U-Diagnose is and then matching its implementation with an evaluation goal. For example, a learner may use teaching simulations for course assignments because they give feedback about choices as the learner progresses through the case study. In our educational setting the students enjoy the challenge and prefer to work in groups while viewing the software. Nursing students within an acute care nursing course use tutorials and simulations related to the subject matter and discuss case studies in their seminars. A U-Diagnose simulation is used at the conclusion of the nursing course as a formative evaluation tool. The results of the test are given to the faculty member to provide a teaching diagnosis for an individual's diagnostic reasoning problems. The respondent, in turn, can use the printout to visualize his reasoning processes for the specific case study. The teacher and learner now have more information about the reasoning processes used, and hopefully both learning and teaching of critical skills is enhanced by the U-Diagnosis evaluation tool. Currently two situations are being used with our students and practicing nurses. Outcomes of their implementation have led to a reexamination of our teaching strategies.

Computer software is not just a supplementary learning resource. It can be integrated more fully in the educational environment by evaluating its design and then implementing it appropriately within the curriculum. Simulations require many different learning skills. The educator should know what these skills are in order to involve the learner in a variety of critical thinking exercises and to evaluate acquisition of these skills.

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# A CBT SUCCESS STORY

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## ABSTRACT.

The following is the highlights of a successful CBT project. The project involved the majority of the faculty and the students on our campus. It tells of the approached use to turn faculty members into competent authors of CBT materials. Every department on campus has participated. In a limited space we will explain what we did and the methods used to accomplish our success.

## THE SETTING.

Oklahoma State University, Technical Branch, Okmulgee (OSU TECH) was founded in 1946. Located in a rural setting, this residential college offers two year programs in twelve major program areas. With the commitment to prepare students for the future, its mission is to provide postsecondary advancing technical education in a residential campus setting culminating with the Associate Degree. The mission is accomplished in a multidimensional program of general studies, related and specific technologies, and cocurricular life for students.

Instructional delivery at OSU Tech is managed through twelve curricula centers or departments. Each curricula center is responsible for one or more programs of study and must also provide courses for programs of study of other departments. Some departments provide campus support services such as food services, repair services, maintenance services, etc. These twelve curricula centers offer a total of 40 programs of study.

OSU TECH is constantly seeking to enhance student learning opportunities. Programs were developed to implement a computer-based alternate instructional delivery system. The purpose of this program is to deliver more student learning experiences outside the class room. Self directed learning outside the classroom enhances what is learned in the classroom.

Extensive planning efforts further defined the project. In December, 1985, we applied to the United States Department of Education for a Title III grant under the Institutional Aid: Strengthening Program. The grant application was subsequently approved with a projected starting date of October 1, 1986.

## THE CHALLENGE.

The objectives for implementing this project which was entitled Computer Aided Instructional Delivery (CAID) were:

1. To use the computer to reach new education objectives which, until now, were difficult or impossible to realize are met.
2. To enhance the way we meet existing educational objectives.

The CAID program that the project envisioned involved not only the faculty but also the students. Every department on campus and every student will either be a provider or a user of CAID programs and systems. In scope the project is massive. The persons who envisioned the program had no real insight to the complexities involved in their proposal. Two of the leading proponents dropped out of the project with 6 month of funding.

CAID program delivery was envisioned to take place on an on-line mainframe computer system with terminals at strategic locations around the campus. The program materials delivered by this system include testing, study guides, and course materials in communication and mathematics skills. In addition CBT based training and interactive video where also written into the goals of the grant proposal. It was proposed that the faculty develop the majority of the test and study guides.

When I joined the staff some 7 months after funding little had been done to meet any of these objectives except for arrangements to install a donated mainframe computer. My challenge was to make the grant goals a reality.

STARTING RESOURCES.

The institution had been donated an IBM 4341 model mainframe computer. They purchased a printer, disk drives and 25 terminals which were to be the bases for delivery of instruction.

Only five percent of the 135 faculty members could be considered to be computer literate. None of the faculty had a dedicated computer for his own use and only 2 or 3 had a personal computer at home.

The faculty and staff had negative feelings toward the project because of the way it was presented to them by the project originators. This resentment was probably expressed best by one of the faculty who stated "CAID over my dead body".

The grant provided slightly less than $200,000 per year in funds and the institution was to provide additional funds. The economic climate in Oklahoma prevented the institution from contributing the total amount planned.

The grant also set the staffing at two people: a director and a programmer. The programmer had just graduated from the school. His job was to maintain the computer operation system and write all of the computer programs required by the project. The staff was expanded to three but was still understaffed.

The best resource that we had was the director of the institution who was dedicated to the development of computer based instruction on the campus and who provided his support at the beginning of the project.

OUR SUCCESS STORY.

Over a period of thirty months we were able to achieve the following:

1. Staff and student involvement. After a hard sales job we were successful in training eighty five percent (85%) of the faculty in personal computer concepts and in the methods of CAID courseware development. Tests have been presented to 1885 students. This is approximately 65% of the student population during the last year.

2. Testing and study guide development. Seventy-five of the faculty have used their planning and spare time to develop over 689 test or study guide modules as of August 1, 1989. An additional 122 modules are in development and are to be completed by September 30, 1989. This will give us a total of 811 modules. Development to August 1st represents over 500 hours of computer-based material. The faculty spent about 5,000 hours on the project and we provided an additional 2,000 hours of release time that was paid for with grant funds. Using our own development methods our average module preparation time is 10 hours. This is roughly 14 hours of preparation for each hour of presentation.

3. Our computer resources have increased significantly. The original IBM 4341 was replaced with a 4341 model 12 which doubles the size and speed on the original unit. We have 150 terminals on-line for student use with an additional 50 terminals available for installation. Terminals are available in 4 locations across the campus for student usage. Most of the above equipment was donated by local industry. In addition to the mainframe we have purchased 15 personal computer systems, 4 interactive computer monitors, 3 Pioneer 6000A video disc players, 2 1/2" tape recorders, 2 3/4" video tape players, a scanner, an image capture system and associated peripheral devices. During the same time period the schools personal computers increased to 475. Some 325 computers are available for student usage.

4. Instructional delivery. During the year beginning August 24, 1988 and ending August 22, 1989 we have presented about 22,500 tests and over 7,500 hours of study guide usage. This is an increase of 350% from the previous year. Over the term of the project we estimate about 30,000 tests and 9,000 hours of study guide presentation was provided.

5. Interactive Media. In addition to the above we are in the process of completing our first interactive video classroom. All of the equipment, the lighting and the sound is controlled from a central podium.The classroom will be used for interactive class presentations and for interactive training. Much of the equipment purchased by the grant will end up in this classroom.

6. Institutional commitment. The faculty, staff and students have accepted the CAID program and continued development is now part of the ongoing responsibility of each department.

7. Return on Investment of time to Faculty. The biggest return of the project has been the saving of class time. Since all testing and study guide

usage takes place outside the classroom the saved time mounts up quickly. The 30,000 tests given equate to 30,000 additional instructional hours. If the faculty member gives 8 tests per trimester he saves 16 class hours, one hour for each test given and one hour for review. If the class meets 3 days a week that is equivalent to 3 extra weeks a trimester. We have saved 650 class hours since the start of the program.

## WHAT THE CAID SYSTEM DOES

### TESTING

Testing using CAID is accomplished on-line. A student takes the test using a computer terminal in a preassigned testing area. Students may take the test at anytime during the designated testing period. No time limit is placed on the test procedure and a student may take the test at his own pace. Acceptance of this testing procedure among the students is positive. The testing procedure presents questions to the student in a random sequence. All students receive the same questions. As the student takes a test, individual questions can be annotated for later review. Annotated questions are presented again at the end of the test sequence. Students can review and revise answers at their discretion.

Benefits from this testing accrue to both students and faculty. From the student view point they can take a test at any time during the test window. The students feel that there is less pressure while taking the computer based test. Students also say that testing is easier on the computer than paper and pencil testing.

The faculty benefits not only from the savings of classtime, as has already been stated but they receive good reports and test results quickly. They receive a test sheet for each student, a class roster with each student's grades, and a test item sheet that shows cumulative responses to each test question plus averages and the number of A, B, C, D, and F's.

### STUDY GUIDES - A SELF DIRECTED LEARNING EXPERIENCE.

Study guides represent a unique use of the computer based training concept. A study guide covers a body of knowledge already presented by the traditional classroom methods. Study guides are made available to students much like books in a library. Students on their own time and volition can access any available study guide from any of the courses offered on campus. They can use the study guides as many times as they want to. No record is kept of study guide access, so the student feels no pressure.

A student selects the appropriate study guide and is asked a series of questions. If the student answers the question correctly, he gets immediate feedback confirming his success and is provided with some information reinforcing the correct answer. The student is asked another question. If the student does not answer the question correctly, the correct answer is shown, and text is presented explaining the correct answer. The student is also referred to other sources, be it printed or video or other computer base learning materials. This sequence is repeated until all of the questions have been asked.

The use of study guides provides an additional learning tool that is available to all students. Students quickly learn that the study guide review is an excellent way to prepare for tests. Study guide terminals are available to the student during the evening hours and on weekends.

In addition to study guides, on-line tutorials are available in both the communication and the math skill areas. These programs cover both remedial and advanced skills. Students can use these programs at any time. They are self-paced and can be tailored to the needs of the individual student user.

Self directed study is something that has to be sold to both the student and the faculty. A steady increase in study guide usage has been noted. Students who use the study guides like the approach. Once the student tries this method of learning we find that he repeats the process and even asks why additional material is not available.

### PERSONAL COMPUTER-BASED DELIVERY SYSTEMS.

A second delivery method for self-directed studies is also employed. Personal computers located in labs scattered across the campus and in the Learning Resource Center are available to the student. Computer-Based Training materials are available through the Learning Resources Center that cover concepts taught in the various courses that employ CAID. CBT material available may be remedial in nature, or it can supplement or enhance materials already presented in the classroom. Over 200 CBT titles are available for student use in the Learning Resource Center. Many of these titles were purchased with grant funds.

HOW WE ACCOMPLISHED OUR GOALS. The first thing that was necessary for us to do is to begin to change the attitude of the staff and faculty toward the project. To this point the attitude of my predecessor was do it or else. To do this, we changed the direction on the project slightly, making the academic council  the advisory committee for the project. This council is composed of the department heads of the school. We encouraged each department head to "buy" into the project. We were successful in this approach to varying degrees with each department head. The grant called for a phase-in of departments over the life of the grant. Three departments were involved the first year. The departments made available 6 faculty who were assigned to the project either full or part-time. A CAID development lab was set up with personal computers and terminals to support the creation of tests and study guides.

The original plans include the use of IBM's IIAS-IIPS package for the creation of courseware with the programmer writing all of the code. This obviously was not a workable solution. The IIPS products were already purchased, so we looked for a way to make the development of courseware easy enough for the faculty to develop their own in order to produce enough materials to meet the grant requirements. We selected a product called Creative Coursewriter to aid in development. Faculty was trained in the use of Coursewriter and in the concepts of test and study guide development.

This approach allowed us to use the personal computer as a method of creating content materials. A word processor was used to create the course content. Coursewriter code was inserted by the Creative Coursewriter package and was then uploaded to the mainframe for presentation. This is a valid concept and works well with proper training. If the user is well versed in computer usage and knows word-processing Creative Coursewriter can be a useful tool for courseware development. Although this procedure was not terribly complex, it took quite a bit of time and certainly was not straightforward. All of the assigned faculty were getting tests and study guides completed, but the process was tedious enough that we knew we were going to have serious problems getting the rest of the faculty, who were not computer literate, to produce courseware.

I began to look for a simpler interface. None was available. The solution was to build a front end to creative coursewriter that was easier to use and was user friendly. One of the faculty took the design and wrote a program that allowed the user to place the questions and answers in appropriate boxes on the screen and then place the data in appropriate screen formats and add Coursewriter code. We tried to apply the KISS theory to all aspects of the project. Good written procedures were developed and adhered to.

The first year ended with all project goals being meet. At the end of the first year we had 155 modules completed. In addition some 125 packages of prewritten courseware were evaluated and 110 of the packages were purchased for use in the Learning Resource Center.

YEAR TWO. Our grant called for us to broaden the scope of participation of the faculty. Remaining members of the original three department were to be trained and five new departments were to be added. To facilitate training, one of the first year developers was appointed faculty development coordinator. It was determined that the training must focus on courseware selection and evaluation, personal computer training, course quality criteria, course development and overall procedures.

We had a real sales job. Meeting were held with the department involved in the second year of the project. The questions asked in these meetings showed that many instructors were not eager to participate. Soon even seemed hostile. They seemed to perceive CAID as a threat, a means of replacing them in their classroom or as something the may force changes in their teaching methods. We were asking the faculty to spend some of their planning and free time to develop courseware. Test and study guides were being presented on the mainframe but the value of this program was still to be demonstrated.

At the same time proliferation was taking place in the first year departments, the second year departments were choosing the people to "break ground" in their areas. We advised the department heads again to choose positive people who would lead the others to want to participate.

With a limited staff, and a new system, we could train only a small number at a time. Our computer system needed to be restricted at first to be sure everything worked smoothly in processing the development output and presenting it to students. We were having amazingly few problems with the system, but we were again reminded that not everyone follows directions. We were all too well aware that we were highly visible when things went wrong. We streamlined the system, reworked our fail-safe procedures, and trained and retrained.

We decided to capitalize on the few people who were excited about the project at first, hoping that word-of-mouth would get others interested. This paid big dividends. By choosing positive people and working closely with them, we began slowly to see attitudes change. At the same time, the department heads were talking up the project and making assignments to be completed. Some instructors only came along because they were expected to. We touched bases often with the department heads, and all agreed that nothing good would be accomplished by insisting on participation from those who were most against the project. Our watchwords were "low-key" and "availability". We kept our presentations low-key and positive and made sure that resources and time were readily available to the instructors.

An amazing thing began to happen about four months into the second year. People who had not been selected in the initial group to be trained began to call and ask how they could get trained. Some asked their department heads if they could get involved. In spite of our limited staff, and with the approval of the department heads, we decided to provide basic training to all who wished to participate. We certainly wanted to take advantage of all enthusiasm. From week to week, we could see it grow. Some of the third year departments began to ask to get included in the training, so they could get a head start. By the middle of the second year, we had provided some training to about ten people in third year departments at their request. Two third year instructors were to be assigned to the development team for the summer.

The grant called for study guides and tests to be developed for at least two courses in the Second Year Departments. The Department heads chose the developers and courses they intended to develop. Before the beginning of the third trimester, eight Instructors were assigned at least half-time from the second-year departments, two from the first year, and two from the third-year, with a total of 12 developers in all. No grant money was extended to the first year or third year departments for development salaries, which shows the extent of the commitment to the project.

With this many people engaged in large-scale developing over the summer, our system was tested to the limit, and considerable revision in record keeping and procedures naturally occurred. The developers met every day for their work period in the CAID Instructor's lab. The lab was open from 7:30 to 4:30. The lab was staffed by the Faculty Development Coordinator, three work study students who assisted with record keeping, and the developers. By the end of the summer, the work study students were participating heavily in validations, at the instructor's request.

It was hard to count completed modules, as they were being completed so rapidly. By the end of the summer, and near the end of the second year, we had a total for the two years of approximately 450 completed modules, representing about 50 courses, with about 160 modules still under development. This accumulated material represented about 150-225 hours of presentation to students. Tests outnumbered study guides about two to one as these were the immediate time payback to the instructor.

TRAINING IN YEAR THREE. With the knowledge that at no time would we ever be able to say that all instructors had been trained, we set 80% as a goal for the third year. As we began training the third year departments, some of the teachers from the first and second year departments kept straggling in. In November, we began training the Small Business instructors, and scheduling the other departments for training. During the week after the end of the second trimester, and just before the Christmas break, we held several workshops for the remaining instructors. Personal Computer training continued on through January. Training was completed for 27 people in the three months. A couple were instructors who had been trained early in the second year, but had not gone any further. They came back for retraining. February and March added 5 more. At this point we had over 750 separate modules on the system. Other instructors were still checking in from time to time to work on their courses or to start new ones. We had settled down into what seemed to be the ongoing maintenance mode -- that is, only curriculum and textbook changes and additional courses would make up the bulk of those starting new course development.

SUMMATION.

Successful projects can happen if the institutional support is provided at the highest level. The faculty must be sold on the projects benefits. The faculty interface must be simple at least at the onset of a project. Instructions to the faculty must take place in the least threatening way possible. The project leader must understand the project and be proficient in the type of courseware to be developed. The leader cannot learn on the job and have a successful project. We are looking forward to an on going CAID program. The user departments are controlling their own development with limited support. Our staff will be working on the integration of Computer Based Training and interactive video into the classroom. We have been successful with our pilot efforts in this area.

A program of this type is of benefit to the student and the faculty. Projects of this type make the instructor more efficient thereby reducing overall costs.

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# LEVELS OF LEARNING C-5B MAINTENANCE

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DAEDALEAN, INC.

## ABSTRACT

Maintenance training for the C-5 airframe involves following a flow chart decision tree in the form of a documented task order to perform fault isolation. The C-5 FIT reinforces the learning of fault isolation of equipment failure through following task orders to arrive at problem sources. Additionally, the C-5 FIT permits progressive practice by allowing for practice mode and nonevaluative training and provides feedback to the student concerning any incorrect or unnecessary equipment checks that were made or any misleading paths that were followed.

## PRESENTATION

### 1. Instructional Theory

Maintenance training for electrical equipment often requires the ability to fault isolate the equipment components to determine the source of system performance problems. The maintenance serviceman will make tests at various points in the system following a flow chart decision tree. The decision tree tells the serviceman which path to follow on the schematic according to the results of his tests. When the apprentice serviceman can correctly diagnose the source of the problem following the flow chart, he is usually determined to be competent enough to send on site to troubleshoot problems.

The apprenticeship usually teaches the apprentice how the equipment operates and how to follow the service manual's decision chart and how to use the wiring diagram to locate faulty components.

Gagne (1970) defines learning of a series of connected stimulus-response behaviors "chaining." This type of learning is often dictated when task completion requires following diagrams or flow charts. Successful ways of reinforcing this instruction or in Gagne's terms "arranging conditions that permit learning to take place" have been accomplished through practicing what Skinner (1951) has termed "successive approximations" of the terminal behavior.

Skinner has used this technique to teach complex behaviors by having subjects complete increasingly more difficult models of the terminal task. Each approximation represents a step closer to completion of the entire task for the actual aircraft.

Brunner (1966) has incorporated this Skinnerian teaching methodology in his "spiral curriculum." The spiral curriculum comprises courses that teach the same tasks at increasingly more difficult levels. For example, an aviation curriculum would begin with a course that allows the student to utilize all of the instruments that he would in flight without leaving the ground. Another course would involve flying without landing, etc. The important difference between this method of learning as opposed to more traditional part-task learning lies in the completion of an entire task at a low level rather than only a part of it. This has been used successfully in teaching complex tasks comprised of discrete components.

Training simulators that teach maintenance procedures particularly lend themselves to following step-by-step procedures of increasing difficulty. One such simulator currently being designed by Daedalean, Inc., the C-5B FIT. incorporates the strategy of learning fault isolation at progressively more comprehensive levels by providing for different types of student practice.

## 2. Purpose and Uses of the Trainer

The Fuel Savings Advisory System/Inertial Navigation System (FSAS/INS) Maintenance Trainer (FIT) is a training device that will provide students with the opportunity to practice troubleshooting, testing, interpreting, and aligning FSAS/INS components of the C-5B aircraft. Additionally, the FIT trainer provides students the opportunity to perform operational checks without the attendant costs of using the actual C-5B aircraft. The FIT trainer shall be used to train personnel with Air Force Specialty Codes 328X4, 325X, 325X1, and 328X1. Training will include normal system operation, operational checkout, and troubleshooting procedures on Basic INS, FSAS Modified INS, and FSAS systems.

The FIT comprises three major assemblies. Assemblies A and B are the Student Stations and Assembly C is the Instructor Station (reference Figures 1, 2, and 3). Assembly A (Trainer Flight Station) contains or simulates all necessary aircraft flight station instruments. The trainee will be able to operate instruments as in the actual aircraft. Instruments are designed to be removed and replaced as in the actual aircraft and will allow the trainee to disconnect electrical connectors to perform wiring harness troubleshooting for fault isolation when TO procedures dictate such actions. Assembly A is configured similar to the actual aircraft.It contains the pilot's, center, and copilot's instrument panel, pilot's and copilot's side panels and a center console. The side panels and center console is designed to allow the trainee to function as in the aircraft with the pilot's side console on his left, the center console on his right and the instrument panel directly in front. The copilot's position is similar to the pilot's except: (1) only the center console will be on his left and the copilot's side console will be on his right; and, (2) the copilot's position will not contain a control column.

Assembly B (Avionics Station) contains all necessary simulated aircraft components to provide FIT maintenance training at the navigators station, flight engineers station, and Avionics Bays No. 1, 2, 3 and 4.

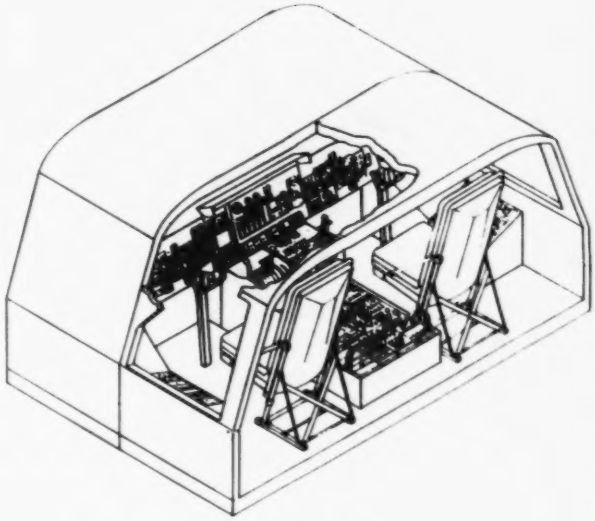

**Figure 1**
FIT Assembly A

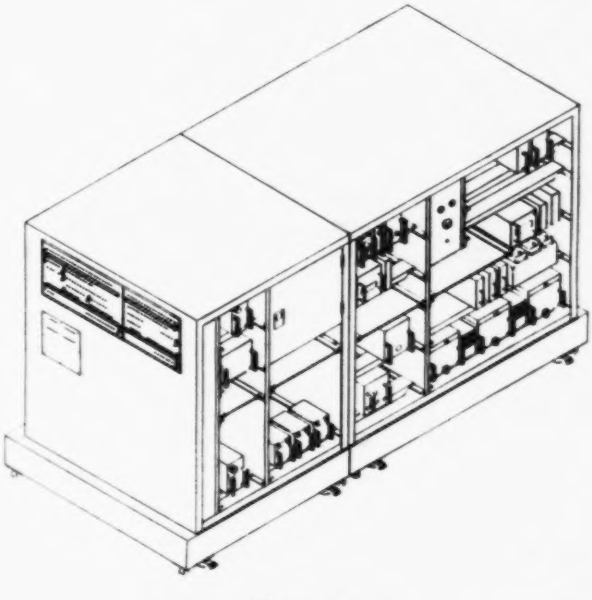

**Figure 2**
FIT Assembly B

The trainer contains the navigators circuit breaker panels as in the actual aircraft. The flight engineers circuit breaker panels; environmental, anti-ice, and APU control panels, and fuel flow indicators will be positioned relative to each other as in the actual aircraft. Similarly, Avionics Bays No. 1, and 2 are located to provide relative positioning for each bay.

The trainee will be able to locate each component within an area (navigator, flight engineer, Bays No. 1 and 2,) as in the actual aircraft. Some components will be able to be removed and replaced as in the actual aircraft. These components will be provided with high fidelity functional mounting hardware. All components are designed to allow the trainee to remove the electrical connector to perform wiring harness troubleshooting for fault isolation.

Assembly C (Instructor Station) includes the computer, instructors terminal and printer. The Instructor's hardware will be mounted in a console. The console is designed around a work area which will unfold, close and lock to contain all components. Storage space is provided for training manuals and supplies. The computer and associated equipment are rack mounted. Assembly A and B are connected to Assembly C by plug-in electrical cables. The host computer and associated equipment control the trainer normal and malfunction conditions at both student stations by providing appropriate electrical signals via computer input and output. The trainer computer operates all functional instruments, controls/displays, circuit breakers and relays to provide the trainee with realistic aircraft simulation.

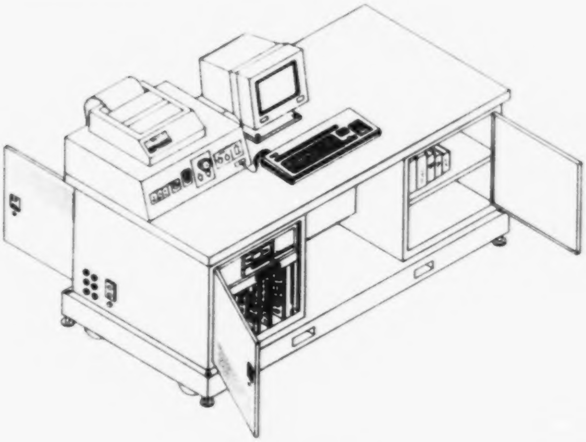

**Figure 3**

**FIT Assembly C**

## 3. FIT Training Tasks

Tasks performed on the FSAS and INS Systems can be broken down into three categories; Operational Checks, Interface Checks and Troubleshooting Procedures. These tasks are the basic elements or steps to completing FIT learning objectives.

1) **Operational Checks.** The student will be able to perform both INS and FSAS operational checks. The FIT Trainer will contain two different INS System configurations; one being the Basic INS System and the other being the FSAS Modified INS System.

Students will be able to locate these components, identify controls and functions of the Control Display Units (CDU)s for each configuration, and demonstrate the ability to perform the following operational checks:

- o Start Up
- o Postflight Malfunction Code Check
- o Lamp Test
- o Position Loading
- o System Alignment
- o Shut Down

FSAS operational checks include locating FSAS components, identifying controls and functions of the CDUs, locating and explaining the functions of each FSAS switch, and demonstrating the following FSAS procedures:

- o FSAS Turn On
- o FSAS Keyboard and Display Checkout
- o FSAS Shut Down

2) **Interface Tests.** The FIT trainer contains several interfaces to other C-5B systems. The student will be able to test the interface to the INS, the triple mix, and the the Standard Central Air Data Computer.

3) **Troubleshooting Procedures.** Troubleshooting procedures include fault isolation using Technical Orders or (TOs). The TO is a step-by-step fault isolation procedure for component fault isolation. Using the TOs and a simulated multimeter, the student shall be able to perform FSAS operational and interface troubleshooting. These procedures are tested by achievement of the following learning objectives for selected operational checks and interface checkouts as well as fault isolating instructor-inserted system problems.

## 4. FIT Objectives

Instructions and conditions for each objective are provided below:

**Objective 1.** Upon completion of this course and given Technical Orders (TO) and a FIT trainer, the student will be able to perform a Basic INS operational check.

**Objective 2.** Upon completion of this course and given TOs and a FIT trainer, the student will be able to perform a FSAS modified INS operational check.

**Objective 3.** Upon completion of this course and given TOs, test equipment, and a FIT trainer, the student will be able to perform three instructor selected Basic INS test procedures.

**Objective 4.** Upon completion of this course and given TOs, test equipment, and a FIT trainer, the student will be able to perform three instructor selected FSAS modified INS test procedures.

**Objective 5.** Upon completion of this course and given TOs, test equipment, and a FIT trainer, the student will be able to troubleshoot a selected Basic INS malfunction.

**Objective 6.** Upon completion of this course and given TOs, test equipment, and a FIT trainer, the student will be able to troubleshoot a selected FSAS modified INS malfunction.

**Objective 7.** Upon completion of this course and given TOs and a FIT trainer, the student will be able to perform a FSAS operational check.

**Objective 8.** Upon completion of this course and given TOs and a FIT trainer, the student will be able to perform three instructor selected FSAS interface checkouts.

**Objective 9.** Upon completion of this course and given TOs, test equipment, and a FIT trainer, the student will be able to troubleshoot a selected FSAS malfunction.

These objectives are completed by finishing one of 5 TOs that provide detailed steps and fault isolation paths.

The FIT trainer is capable of simulating 40 malfunctions altogether including 20 supporting the Basic INS and FSAS/INS, and 20 supporting the FSAS.

The Basic INS and FSAS/INS malfunctions include:
- 10 Operational Malfunctions
- 10 Interface Malfunctions

The FSAS malfunctions include:
- 10 Operational Malfunctions
- 10 Interface Malfunctions

## 5. Training Conduct

The uniqueness of teaching C-5B maintenance is the level of successive approximations to the terminal tasks that can be practiced on the trainer. These have been built into the trainer through the three modes of instruction that the instructor can select -- a. unstructured or nontargeted objective training, b. practice mode training, and c. evaluation mode training. Each of these is described below.

a. **Unstructured Training.** When the instructor chooses this training mode, the student shall be able to practice on the FIT components without a predefined TO to structure the session. The learning is self-paced and conducted on components of the student's choice.

b. **Practice Mode Training.** When the instructor chooses this training mode, the student follows a prescribed TO but receives no evaluation. Error messages are delivered to the instructor station but errors or deviations from the TO will not be recorded.

c. **Evaluation Mode Training.** When the instructor chooses this training mode, the student demonstrates accomplished learning objectives to the instructor. The FIT will freeze upon error or deviation from the applicable TO, and errors shall be recorded on the student's record for evaluation.

Practice or evaluation mode training begins with the instructor demonstrating the required maintenance actions and pointing out the appropriate caution areas. The instructor then inserts the appropriate faults via software menu choices and announces a symptom to the student.

Instructors announce problem symptoms to the student who uses a TO to perform operational and interface checks and fault isolate faulty components. To diagnose problems, students use a simulated multimeter and read gauges and annunciator lights. Following the fault isolation paths in the TO, the student performs the indicated checks while the instructor observes student performance. The CPU at the instructor station keeps track of wrong steps and paths taken by the student and prints out this information for the instructor.

When the student feels that he has located the cause of the problem, he announces his diagnosis to the instructor. For an instructor to feel comfortable with student performance and be assured of his readiness to conduct C-5 maintenance, he will have the student perform 3 operational checks, 3 readiness checks, and diagnose 3 malfunctions.

FIT training will be conducted in small groups. Student failure on any procedure will require that the instructor indicate the problem to the student and that the student begin the check or diagnosis again from the beginning. The instructor can print out reports of student performance to indicate to him any specific problems that continue to occur.

The instructor observes student actions and provides feedback necessary to assure that the student achieves the desired learning objectives.

## 6. Unique Training Features

Unique training features of the FIT device include the multiplicity of faults that can be simulated, its interface with several other electrical systems of the C-5 aircraft, and the modes of training which it permits.

Nearly 400 faults can be simulated with the FIT trainer and the combinations of problem symptoms is virtually limitless. This allows for a variety of difficulty levels for fault diagnosis. The C-5 FIT also interfaces with several of the other systems of the C-5 aircraft including the Tactical Air Navigation system, and the Standard Central Air Data Computer. This allows the trainer with modification to be used for other C-5 maintenance training tasks as well as some areas of flight instruction.

Finally, the FIT trainer allows for varying degrees of successive approximation of the terminal tasks. The C-5 FIT trainer allows for maintenance practice without structure or evaluation, practice on the terminal task under realistic task conditions without evaluation, or classroom-type instruction with evaluation and instructor feedback. All of these conditions allow the instructor to choose the type of practice desired by the student or requested by the instructor to make the student feel more comfortable demonstrating maintenance techniques and performing terminal tasks.

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# A Graduate Program in Educational Computing

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## Abstract

This paper traces the formative years of a Master of Science in Education Program in Educational Computing at Baruch College of the City University of New York (CUNY). The program, approved in 1986, aims to develop articulate educators who will harness the powers of technology to strengthen the teaching and learning processes. Unique among graduate education computing offerings, it maintains that American schools must be restructured to encourage communication and interactive learning throughout the school day and that computing technology will provide the vehicle for reorganization.

This is the only Masters program in the greater New York area offered by a public university; tuition is affordable by beginning teachers in state, city and private schools. Teachers who enter the program with provisional state certification are eligible for permanent certification in the provisional area upon completion of the degree. (New York State does not offer certification in educational computing.)

## Educational Computing

The program, under development within the prospectus framework (Kay, 1984), culls ideas and advice from the teacher education literature describing programs at Teachers College, Columbia University (Budin & Cunniff, 1988), University of Pennsylvania (Freyd & Kahn, 1988), University of North Colorado (Lounge & Walker, 1988), and Cornell University (Sutphin, 1987) and from the literature that surveys teacher preparation in the use of computers (Bruder, 1988; Ekhaml, 1985; Fulton, 1988; Gray, 1986; Kull & Archambault, 1984; ; Nathan, 1986; Vakos, 1986; Wright, 1986). The coursework is organized into two logical groups: foundation/core and tool/development (Figure 1). In the foundation courses, students develop proficiency in a wide range of computer software and explore ways of using the various software products to enhance oral and written communications and decision-making skills in the classroom. These courses are open to students in all teacher education programs at Baruch and are becoming very popular graduate electives; the first two provide minimal computing competencies recommended for all teachers and school supervisors.

The tool courses facilitate the development of a spectrum of skills needed to create computer courseware. The motivation to write educational software was the stated objective of each of the students enrolled in the program. Similarly, Taylor (1988) at the University of Maryland, Baltimore and O'Neill (1987) at the University of Southern California reported that students enrolled in their educational computing programs to learn to develop computer-based learning and training materials.

The culminating experience is the creation of a product that will enhance education. The project comprises a computer-based learning module, a guide for teachers, a manual/worksheets for students, a needs assessment, a description of the software environment, structure charts and flowcharts. Two guiding principles obtain: be careful not to replicate existing software and be ready to defend electronic learning as the best media for delivery of the topic.

**Figure 1: The developing program**

**Foundation courses**

1. Fundamental computing competencies (range of computer use in schools, hands-on IBM-PC Logo and DOS, educational software exploration/ evaluation).
2. Productivity learning tools (classroom applications using wordprocessors, databases, spreadsheets, graphics programs)
3. On-line, data-base search and retrieval (library-based searching of educational databases).
4. Computer-based, information management for educational administration (using productivity tools).
5. Pascal in the classroom (structured logic, algorithms and flowcharting using Turbo Pascal)

**Tool courses**

1. Designing computer courseware I: authoring/delivery systems (environments for CAI, flowcharts, structure charts, algorithms using BASIC).
2. Designing computer courseware II: instructional design/ development (strategies for effective electronic instruction, sophisticated algorithms).
3. Designing computer courseware III: software documentation (on-line and print user guides and worksheets).
4. Testing and evaluation (developing effective test items, evaluating mastery of learning).
5. Educational research (methods of conducting research; creation of a publishable paper).

**Culminating course**

Independent project (needs assessment, software, documentation and ancillary materials).

### The student body

Due to restrictive admissions criteria, the program is small; as of Spring 1989, 22 students completed contracts indicating that they plan to obtain the degree. Within the group are faculty from community colleges, high school teachers of foreign language, occupational education, business education, accounting, history, and special education, elementary school teachers, the acting director of a CUNY academic computing lab, an administrator at the central board of education, data trainers from the private sector, and teachers in proprietary schools. Few of the students knew one another before joining the program yet many excellent work relationships have been established through interactive learning and communication. Members of the program share the attributes of intellectual curiosity, an ability to work hard in a cooperative environment, a sense of adventure and a love of learning. The multicultural backgrounds of the students contribute immeasurably to the learning experience in preparation for teaching in the global classroom of the information age.

### Learning environment

To serve the needs of the program, a cooperative, technological learning environment ("the lab") was created. The traditional row and column classroom design is an anachronism (Helsel, 1988); learning needs can no longer be met with an industrial model. Suggestions from research conducted by students in the program (Abramson, 1987b), and the literature of cooperative learning (Bernagozzi, 1988; Hanson-Smith, 1987; Helsel, 1988; Johnson and Johnson, 1986; Johnson, Johnson & Stanne, 1985; Ratzki, 1988; Sharan and Sharan, 1987; Slavin, 1987) helped define the physical configuration of the environment.

The computer systems - keyboard, color monitor, disk drives/processor - are arranged in clusters of four (one printer is shared by the four stations) with all wires internal to the grouping and removed from the floor for easy maintenance. Each student station comfortably accommodates two chairs to encourage team work; there is sufficient space between clusters for students to move around freely to observe and question work at other stations. See Figure 2.

### Learning implementation

Since all students come to class a a full day at work and many have family responsibilities as well, most chose to no more than two courses per semester and plan to complete the program within three or four years. Classes meet once weekly 150 minutes. During the first two years, each session met for 75 minutes in a traditional classroom setting followed by

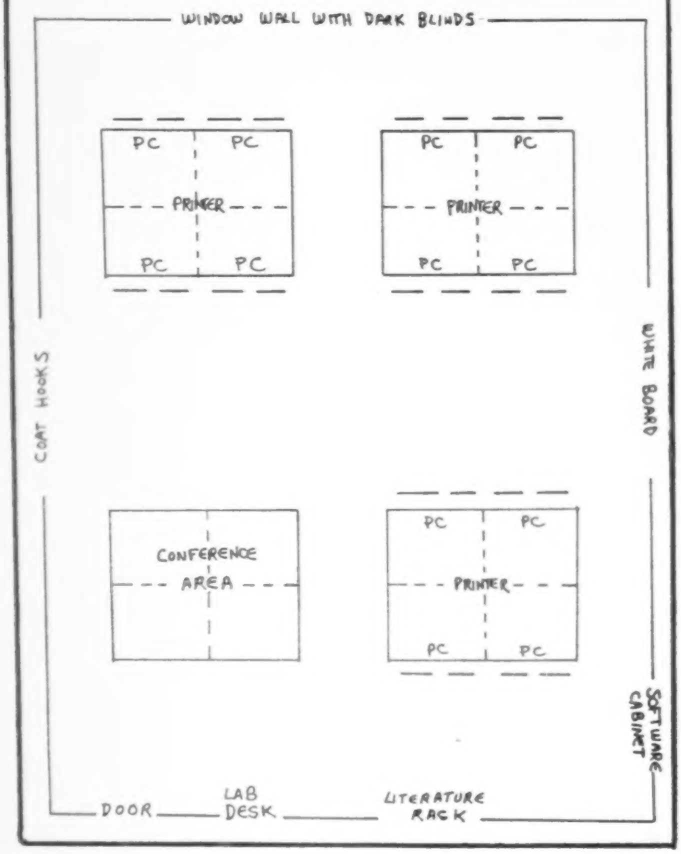

Figure 2: The learning environment

minutes of supervised practice in the lab. Based upon student feedback, instructor feedback (Kaplan, 1987; Marrapodi, 1986; Bloch, 1987) and this author's notes, classes now meet for the full 150 minutes in the lab with large and small group instruction interspersed as needed. Course sections are limited to 16 students due to the physical size of the lab and the intellectual demands of the multifaceted syllabii.

Attendance, although voluntary, is excellent. Students frequently become unofficial lab assistants in courses they have completed; there is an sense of community fostered by working cooperatively. Students are encouraged to read widely and constantly within the literature to keep pace with the dynamics of this discipline and reports of new products and new research are a regular part of each class.

The course demands are intense because specific computing skills must be mastered before each computer-based-learning tool can be applied to curriculum development, classroom management, methods of teaching and other items on the teacher education agenda. Each lesson that incorporates computer use follows a plan (Abramson, 1987) that includes goals, objectives, target audience, time frames, prerequisite knowledge, preparatory lessons, instructional materials, procedures for implementation and evaluation activities. Key words used to guide lesson development are interaction, participation, selection, communication and articulation. Foundation courses all require a written reviews of relevant, current literature so that students become conversant with on-going developments and with experts in the field.

The hands-on component of each course allows students to experiment with the concepts developed in group discussion. The process of cooperative learning is difficult one to master because most adults, who are products of western culture, are conditioned to learning as a solitary process. During the first few lab sessions, students work tentatively alongside one another, and, under the watchful eye of the instructor, pay lip service to cooperative work. However, the very nature of computer-based learning eventually breaks down student reserve and, before long, awarenesses are developed and articulated for the educational benefits of sharing the learning process. The role of the instructor is to suggest, to trouble-shoot, to draw attention to an item, to encourage and to guide. Students are free to sample, explore, borrow, share, reject, question and challenge.

The culminating project must be approached as a personal challenge; this is not an assignment that one does to "get it over with". Students, who complete their coursework and are still undecided about a subject or grade level for their project, are encouraged to research, converse and "hang-out" until the right thing comes along. (One of the students reported that his fiancee calls his project "Jezebel", the "other woman" who has first claim on his time.)

By the end of the 1988-89 school year, six students completed their projects and were awarded their degrees. All rejected the option of using the available authoring system or an applications program as the delivery system and chose the flexibility offered by working with a programming language (Abramson, 1988). Three projects were executed in GWBASIC, one in True BASIC, one in Turbo PASCAL, and one in C. Since the thinking and planning is done with charts, the variety of languages used is a reasonable outcome of the developmental efforts. The projects are: sequencing events (primary grades), cardinal numbers in Spanish (academic high school), the working citizen (vocational high school), numeric data entry trainer (adult education), conjugating verbs (English as a second language) and microcomputer concepts (higher education).

## Looking ahead

The realities of schools budgets demand that extensive field testing be conducted before major technology investments are undertaken. The use of telecommunications in the classroom has been one of the "hot topics" during the last two years. Although there is little research reporting measurable differences in achievement through use of this tool in the teaching process, telecommunication tools have shown value in alleviating the isolation common to classroom teachers. Interactive video (IV) in the classroom, another area of interest to educators, is very costly and its educational benefits are too ephemeral to make IV a high priority at this time.

The hardware innovations that promise to improve interaction between student and computer are the touch screen, natural voice output, greatly improved screen resolution and color, music output, and animation. An authoring system would be the logical choice of delivery system for software development incorporating these enhancements. Topics in selected courses may change as more sophisticated equipment is invented and made available to schools but the basic building blocks of the learning processes will obtain.

These early years of the program have been very instructive to the faculty and students. Even if one accepts the assumption that technology has the potential for strengthening teaching and learning, great effort must be devoted to the very complex processes of definition, identification, tool mastery and classroom restructuring. Nathan (1986) aptly compares the computer to a rocket capable of reaching new heights but also capable of grave destruction. Teachers must be proficient and comfortable in a technology-based environment before they can effectively prepare students for successful adult functioning in an information-based society. Through experience we have learned that "overview" courses do not provide useable skills and "immersion" courses demand very large commitments of time. Defining learning as a measurable change in behavior, students who persist with the program report positive changes in their own teaching behaviors, even when this teaching does not involve computers. In 1986, few students had microcomputer access outside of class. Now, only three years later, every student who has completed more than two courses, has a system at home or at work.

The program is growing despite existing difficulties with restrictive admissions criteria, hardware and software acquisition on a very limited budget, a lack of support personnel, and time constraints common to part-time, commuting, graduate students. Slowly, by word of mouth, this fledgling program is attracting students who are willing to invest inordinate hours of time and to endure countless frustrations in hope of being instrumental in establishing the computer-based age of education. We are at the crossroads of a unique time in American education; this is an excellent opportunity for teachers to explore, experiment and question, to develop a teaching style that incorporates technology, promotes communication and prepares students for the world of work in the 21st century.

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# STANDARDS FOR CERTIFICATION OF COMPUTER TEACHERS

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## ABSTRACT

A nationwide study of certification standards for teachers of computer related subjects showed considerable variation across the states. Some patterns in subjects and nature of certification programs were observed. The author presents recommendations for programs which are justifiable in terms of job expectations and meet standards for most states.

## INTRODUCTION

The introduction of the microcomputer into the schools over the last fifteen years has given the states a new content area for which to determine certification standards. That the advent of the computer into the school curriculum has not resulted in one tidily packaged offering further confused the issue. Offerings from elementary keyboarding to college level courses abound in the schools The problem was no less challenging for teacher education institutions which were faced with teaching the most elementary computer literacy to some of their students and faculty and with preparing others to teach Advanced Placement Pascal.

This paper deals with the following: the possible certification areas, the results of a survey concerning required certification programs in computer related fields, and recommendations for action based on the patterns observed in this study.

## POSSIBLE CERTIFICATION AREAS

### Computer Using Educators:

These teachers have responsibility for teaching in fields other than computers. They may teach their students by means of computer assisted or managed instruction. Their students may use word processing as a production tool in composition or journalism classes; data bases as research tools in science or social science classes. The teacher and students may use the computer to better display the graphs of complex mathematical functions or to modify the blueprint of a building to be constructed. In short, the regular classroom teacher who is already preparing students for the technology of the twenty-first century.

### Teacher of Computer Literacy Courses:

One of early offerings in many school districts was a course in Computer Literacy. Although it is not the intent of this paper to define this term, the course was usually characterized by greater breadth than depth. If the course was listed as a separate offering in the middle level, junior or senior high school, the teacher became a candidate for certification.

### Teacher of Computer Applications:

Computer applications courses are usually taught in Business Departments in senior high schools. Their objectives usually involve vocational level proficiency in the use of one or more word processing, spreadsheet, data base, or accounting packages. There is frequently a less intensive course intended for a general audience.

### Teacher of Computer Science:

Computer Science courses involve the study of problem solving using computer languages. The approach to programming is usually structured and focused on algorithm development. The languages usually taught are either

BASIC or Pascal. Some school districts have three or more years of such courses usually culminating in Advanced Placement Pascal.

**CERTIFICATION PROGRAMS**

In the Fall of 1987 a survey was conducted of the State Departments of Education in all 50 states to determine the existence and nature of certification standards for teachers of Computer Literacy, Computer Applications, and Computer Science. As several states had programs under development at that time, a phone follow up was conducted in February, 1989. The findings related to certification are reported below.

**Computer Using Educators:**

The survey did not address the question of computer using educators. Information included in surveys and perusal of other literature gave the clear picture that in almost all states there is no special certification required for the Computer Using Educator. It is becoming increasingly common for states to require some level of computer literacy for their new candidates for teacher certification at all levels. The following table shows the states which indicated specific requirements for teachers of Computer Literacy, Computer Applications, and Computer Science:

CERTIFICATION REQUIRED FOR TEACHING

| State | Comp Lit | Comp App | Comp Sci | Hrs for Comp Sci | |
|---|---|---|---|---|---|
| ALASKA | | | Y | PA | |
| FLORIDA | | | Y | PA | 21 |
| ILLINOIS | Y | Y | Y | | 32 |
| INDIANA | Y | Y | Y | | 12 |
| KANSAS | | Y | Y | PA | 15 |
| KENTUCKY | | | Y | | 18 |
| LOUISIANA | Y | | Y | | 18 |
| MISSISSIPPI | Y | Y | Y | PA | 15 |
| NEBRASKA | | | Y | | 15 |
| NEVADA | Y | Y | Y | | 12 |
| N. CAROLINA | Y | Y | Y | | 18 |
| OHIO | | Y | Y | | 30 |
| OKLAHOMA | Y | Y | Y | | 18 |
| SOUTH DAKOTA | Y | Y | Y | | 8 |
| TEXAS | Y | Y | Y | | 24 |
| UTAH | Y | Y | Y | | 24 |
| VERMONT | | Y | Y | | 15 |
| WISCONSIN | | | Y | | 22 |
| WYOMING | | | Y | PA | 15 |

**Computer Literacy:**

Many Computer Literacy courses are taught in the elementary, middle level, or junior high school. The teachers in many of these schools are certified K-8 or K-9 and may teach any content at that level with few or no restrictions. Thus they are frequently untouched by computer studies certification standards aimed at the secondary school teacher.

For those eleven states showing a certification standard for teaching Computer Literacy at the middle/junior high school, the following requirements were reported, estimated, or inferred: IL (5 sh for Mathematics or Business Teachers, 32 sh otherwise, IN (12 sh), KS (15 sh), LA (9 sh), MS (15 sh), NV (6 sh), NC (18 sh except for Business or Mathematics Teachers), OK (6 sh for Business, Mathematics, or Science Teachers, 18 sh otherwise), SD (8 sh), TX (0 sh, but competency to be documented), UT (3 sh). In most states the Computer Literacy endorsement is considered an additional teaching field. Some states required courses in methods of teaching computer literacy or computer science education. Most did not specify the nature or content of the course requirements.

**Computer Applications:**

Twelve states reported a certification standard for teachers of Computer Applications. In many other states business teachers, with or without a data processing endorsement, taught these courses with no additional certification required. In several cases the requirements for teachers of Computer Applications was the same as for that of either Computer Literacy or Computer Science.

For those twelve states showing a specific certification requirement for teachers of Computer Applications the following requirements were stated, estimated, or inferred: IL (5 sh plus Business or Mathematics), IN (6 sh plus Business), KS (15 sh), MS (15 sh), NV (6 sh)), NC (18 sh except Business or Mathematics), OH (30 sh), OK (6 sh for Business, Mathematics, or Science), SD (8 sh), TX (9 sh or 15 sh), UT (3 sh), VT (15 sh). In most states the Computer Applications endorsement is considered an additional teaching field.

Some states required courses in methods of teaching Computer Literacy or in computer science education. Most did not specify the nature or content of the course requirements.

**Computer Science:**

The table above lists the semester hour requirements for Computer Science certification in the nineteen states which have such an endorsement. Five states (AK, FL, KS, MS, and WY) are designated as PA which means that the certification agency approves the program of a teacher education institution without specifying the number of hours in the program. The number given is the estimated average number of credits found in Approved Programs. In most states the Computer Science endorsement is considered an additional teaching field.

Some states required courses in methods of teaching Computer Science or in computer science education. Many did not specify the nature or content of the course requirements.

## Exceptions:

There are exceptions to the numbers shown for some states. In Illinois teachers of Business or Mathematics can obtain an endorsement with only five additional semester hours. The 32 semester hours shown is for a person having neither of those teaching fields. In Indiana a Mathematics teacher can obtain the Computer Science endorsement with only six additional semester hours of credit. In Oklahoma a Business, Mathematics, or Science teacher can obtain the Computer Science endorsement with only six additional semester hours of credit.

In some states there is a general standard for secondary education certification fields (usually about 18-24 semester hours of content). In some of those states this became the default standard for all computer related certifications. These states were not considered to have adopted a certification standard for computer related courses and are not reported in this study.

## RECOMMENDATIONS

### Computer Using Educators:

The efforts of states to require technological literacy of all preservice should be encouraged and made universal. All teachers should become computer users at some appropriate level. This author sees little point in specific certification standards for teachers using computers in such ways.

### Computer Literacy:

This is a difficult and shifting field. The day of special courses in Computer Literacy may be drawing to a close. As more teachers become Computer Using Educators, the infusion model is becoming more realistic for Computer Literacy. If standards are required for such teachers, they should include the following courses:

1. Computer Literacy: This should include history of computing, structure of computers, uses and misuses of computers, employment opportunities in computing, ethics, hardware and software evaluation, care and maintenance of equipment. . . . . . . . . . . . . . 3 sh
2. Computer Language I: Possibly BASIC or LOGO. Sufficient study of a computer language to be able to write programs of moderate size and make use of various I/O and storage devices. . . . . . . . . . . . . . 3 sh
3. Applications Software I: This should give proficiency in at least one set of software applications having word processing, data base, spreadsheets, and desk top publishing applications. The course should include a study of application and accessory packages likely to be found in a school setting . . . 3 sh
4. Methods of Teaching Computer Literacy: Curriculum, materials, methods, equipment, and software likely to be found in school settings. . . . 3 sh

This endorsement could be added to any teaching field, but the requirements should not be reduced due to the nature of the other field.

### Computer Applications:

Posssibly the best combination here would be in conjunction with certification in Business Education. Such a person would have several courses related to business data preparation and processing. Many of the courses taught might be intended for vocational usage. For such persons the Applications Software I and II courses may well be satisfied by other courses taken in the Business certification program.

1. Computer Literacy. . . . . 3 sh
2. Computer Language I. . . . 3 sh
3. Applications Software I. . 3 sh
4. Applications Software II: This course should provide an in depth study of two or more sets of major applications packages which run in different environments. Packages found in the workplace should be emphasized . . 3 sh
5. Methods of Teaching Computer Applications: Curriculum, materials, methods, equipment, and software likely to be found in school settings . . 3 sh

### Computer Science:

The program described here is an additional endorsement to another secondary education teaching field. If it were desired to make this a major certification field, then additional hours in computer science should be added.

1. Computer Literacy. . . . . 3 sh

2. Computer Language I: This teacher does need to know at least BASIC and probably LOGO in addition to the Pascal shown below . . . . . . . . . 3 sh
3. Pascal I: Structured programming using Pascal. . . . . . . . . . 3 sh
4. Algorithms and Data Structure: A more advanced course in Computer Science requiring highly structured programming of complex problems. This would have a prerequisite of Pascal I . . . . . 3 sh
5. Numerical Analysis: This will require a good background in mathematics, but covers some of the ideas found in the Advanced Placement Course . 3 sh
6. Applications Software I. . 3 sh
7. Methods of Teaching Computer Science: Curriculum, materials, methods, equipment, and software likely to be found in school settings. . . . 3 sh

Integrated Approach:

If the demands of the certification program, the job marketplace, or the teacher education institution demanded it, it would be possible to combine the three programs and provide one person certified to teach in all three areas. This could be done within 24 semester hours if the three methods courses were combined into one. This would be reasonable if all students in the course had common goals and backgrounds.

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# DEVELOPING HYPERMEDIA TRAINING MATERIALS FOR A NATIONAL HUMAN SERVICES COORDINATION PROGRAM FOR AT-RISK YOUTH

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## ABSTRACT

Cities in Schools, Inc. is a national nonprofit program addressing the critical problem of coordinating the providing of human services to at-risk youth and their families. It seeks solutions to problems such as school attendance, literacy, drug and alcohol abuse, teen pregnancy, and school violence.

Hypermedia training materials are being developed at Lehigh University for staff and personnel of the Cities in Schools Program, as part of an overall training curriculum. This paper provides an overview of hypermedia and presents specific examples of how hypermedia technology is applied in the Cities in Schools project. It describes the overall instructional design for the total curriculum, and the design and development of hypermedia materials in the context of that overall training curriculum design. Considerations in designing hypermedia materials are discussed. Special features incorporated in the hypermedia materials to promote their effective use by naive users are described. Insights gained and lessons learned from the experience are presented.

## INTRODUCTION

### The Cities in Schools Program

Cities in Schools, Inc. (CIS) is a national non-profit corporation with headquarters in Washington, DC, and regional offices in Pittsburgh, Atlanta, Chicago, Los Angeles, and Austin, Texas. Recognized as a national leader in promoting and facilitating the coordinated delivery of existing health, social, education, and other support services for at-risk youth and their families, Cities in Schools seeks to develop private/public partnerships designed to connect appropriate human services with at-risk youth in addressing such critical issues as school attendance, literacy, job preparedness, teen pregnancy, drug and alcohol abuse, teen suicide, and school violence. Cities in Schools is in the process of establishing and providing training and technical assistance to a national network of centers to coordinate the delivery of multiple, existing social services to at-risk students and their families.

### The Cities in Schools Program Curriculum Project

In February, 1989, Lehigh University was awarded a contract to develop a training curriculum and produce related training materials required to train staff, board members, and others in the concepts, practices, and strategies which underlie the Cities in Schools process. Three modules (out of an eventual total of ten modules) will be developed and tested during the first phase of the project (Spring, 1989). These modules will cover:

- The history of Cities in Schools;
- The national, regional, and local organization of Cities in Schools;
- The CIS prototype replication process, which describes the specific steps taken to establish a local, operational CIS services delivery system.

Each module of the training materials will be accompanied by supplementary computer-based hypermedia materials. The authors had major responsibility for designing and developing these materials. (Professor Harvey is Associate Professor of Educational Technology and Computer Science. Mr. Story is a doctoral student in Educational Technology.) In the following section, we will describe the concept of hypermedia. We will then describe how that concept is applied in the Cities in School Curriculum Project.

## AN OVERVIEW OF HYPERMEDIA

Hypermedia (also referred to as interactive multimedia) is an extension of the concept of hypertext, a term first coined by Ted Nelson (1967) to denote nonsequential writing and reading. Hypertext applications utilize a computer to present textual materials with built-in linkages among words, phrases, and larger sections of the text. Users, for example, when they encounter an unfamiliar word, may point at that word in some manner (for example, by using a mouse or a light pen with a touch-sensitive screen). The screen display then automatically changes to a text segment which provides a definition of the word, examples of its use, background information about the origin and development of the term, or other relevant information. Terms within this text material may be similarly linked to other relevant text passages.

A key feature of the concept of hypertext is that in theory, both the developer of the text and the user can establish linkages among various parts of the text. Each reader, then, can organize the material according to his or her own needs and interests.

Hypermedia represents an extension of the concept of nonsequential text to include additional components such as computer-generated two- and three-dimensional graphics, digitized photographic and video images, data sets (for example, electronic spreadsheets or data bases), sound, and animation. Nicole Yankelovich defines hypermedia (Yankelovich, Meyrowitz, and van Dam, 1985) in these terms: "We use the word **hypermedia** to denote the functionality of hypertext but with additional components such as two- and three-dimensional structured graphics, paint graphics, spreadsheets, video, sound, and animation. With hypermedia, an author can create links to complex diagrams, texts, photographs, video disks, audio recording and the like."

With hypermedia, an instructional developer can create links to complex diagrams, texts, photographs, videodiscs, audio recordings, and other multimedia materials. A hypermedia application in history, for example, may allow the user to select a name, then present the user with a high-resolution photograph of the person named; a biographical sketch; a picture of the city in which the person lived; a description, with illustrations, of the person's major contributions to history; or other relevant materials. Each of these could be accompanied by spoken narrative descriptions or by music.

## HYPERMEDIA AND PHASE ONE OF THE CITIES IN SCHOOLS PROJECT

### Instructional Design for the Cities in Schools Curriculum Project

Development of the supplementary hypermedia materials for each module will be coordinated with the development of print and other materials for those modules. The particular instructional design approach used for the entire curriculum will be based on a systems approach delineated by Robert Gagne (1970, 1979, 1987) and will use the specific application of that approach developed by Walter Dick and Lou Carey (1985). As modified to meet the needs of the Cities in Schools project, the steps involved include:

1) Explication of Goals. An analysis of the goals of the Cities in Schools program will be carried out. An explication of those goals will be validated by Cities in Schools staff.
2) Instructional Analysis. A schematic flow chart will be used to illustrate the specific content and skills to be developed through each module.
3) Statement of Performance Objectives. A sequence of quantitative performance objectives will be developed for each step in the instructional analysis.

4) Learner Analysis. The particular characteristics of the adult trainers, board members, and other recipients of the training will be analyzed, as a guide to developing instructional materials to meet their needs.
5) Instructional Strategy. Decisions about the sequence of instruction, particular content to be included, practice exercises, feedback, and testing and evaluation will be incorporated into an overall instructional strategy.
6) Materials development. Draft materials will be developed, pilot tested, and revised.
7) Preliminary evaluation of draft materials will include verification of content validity by the instructional design team and by Cities in Schools staff.
8) Summative evaluation of completed instructional materials will be carried out through analysis by content experts and through questionnaires to participants in field testing.

Once the materials are developed, training sessions for Cities in Schools training personnel will be carried out at Lehigh University. Training in the use of the hypermedia supplementary materials will be carried out using the microcomputer laboratories of Lehigh's Educational Technology Center.

### Development of the Hypermedia Component of the Cities in Schools Training Materials

Development of the hypermedia supplementary materials was closely coordinated with development of the rest of the training materials. In particular, the Dick and Carey model was followed closely. The goals explication, instructional analysis, objectives, learner analysis, and instructional strategy developed by the instructional development team for the overall curriculum were utilized as guides to development of the hypermedia supplementary materials.

The description above indicates that the development of hypermedia training materials is considerably more complex that the development of more traditional training materials. Development involved identifying a wide range of potential materials as well as appropriate linkages among those materials. Existing materials such as photographs, slides, text, audiotapes, and tables of data had to be converted to computer-useable form, then integrated into an overall application.

Designing a nonlinear, nonsequential curriculum application requires considerable effort to identify potentially useful linkages among materials covered, and to make it possible for the user to explore those linkages without becoming lost or overwhelmed by the volume or complexity of training material. Clear guide mechanisms must be available to the user in order to 1) indicate to the user where he or she is in the overall materials; and 2) to provide indications of how to move from one part of the material to another section. A variety of guide mechanisms were utilized in the Cities in Schools hypermedia materials.

For Phase One of the project, encompassing the development of the first three modules during the Spring of 1989, the development environment was **HyperCard** (Apple Computer) and Macintosh SE microcomputers. Doctoral students in Educational Technology served as graduate assistants on the project. Undergraduate students in Computer Science assisted with programming. The Cities in Schools hypermedia materials developed are designed to be utilized on a Macintosh Plus, SE, or SE-30 with at least a 20MB hard disk drive

Phase One of the project utilized appropriate multimedia materials available from the archives of the Cities in Schools Program. Visual materials for Phase One included text, still photographs, drawings, and computer graphics. Conversion of the original print materials to digitized form was carried out using the facilities of the Interactive Multimedia Laboratory located in the Educational Technology Center of Lehigh University. Audio materials consisted of short digitized music selections and recorded voice narrative.

### Cities in Schools Hypermedia: Description and Features

The Cities in Schools Curriculum Project began in February, 1989, and completed Phase One of the project (the development, testing, and related staff training for training modules on history, organization, and the Cities in Schools replication process) in August, 1989. We will now discuss the overall structure of the hypermedia modules and some special features incorporated into the Cities in Schools hypermedia modules to facilitate their effective use. We will then describe how hypermedia was used to present the concepts in the CIS modules on the history, organization, and the Cities in Schools replication process. In the following sections we will discuss the advantages of hypermedia for training, and describe plans for the next phase of the project.

The Overall Structure of the CIS Hypermedia Modules. Each screen is divided into two major sections. Across the bottom of each screen are a series of buttons representing the major sections of the module, as well as buttons for module objectives, self-check, browsing, and for quitting the module. This area of the screen remains the same for each card in a specific module.

Each screen has a title across the top; the title is in the same position on every screen. The rest of the top portion of the screen is used to present information and for buttons used for selecting additional topic-specific information.

The use of titles at the top of the screen and the same set of navigation buttons across the bottom assists the user in keeping track of his or her position in the module. As a further aid, one of the major navigational button corresponding to the user's current position in the module is always highlighted.

Each module contains screens with text, computer-generated graphic material, and digitized still photographs. Digitized speech is used to present the CIS philosophy, and additional digitized sound effects and music are used where appropriate. Several long documents from the print training materials (the 29-page history, and the 7-page overview of the organization of CIS) are included in the hypermedia modules; users may read these texts using scrolling text fields.

The objectives of the module are available to the user at any time by clicking the "Objectives" button. In some modules, the objectives are tied to specific suggestions for ways to use the module in order to meet the given objectives.

An online self-check is available to the user at any time. The user selects the appropriate answer by pointing and clicking. The results (correct and incorrect responses) are displayed on the screen, and updated dynamically as the user progresses through the module.

Two types of browsing are available. If the user chooses to browse by specific word or term, he or she is asked to specify the word or term. Every screen which contains the word or term is then displayed in turn. If the user chooses to browse by topic, a list of topics contained in the module is displayed. The user selects a topic by pointing and clicking; the relevant section of the module is then displayed.

A unique feature of the browsing by topic facility is that each topic which the user has previously accessed (in any fashion) is check-marked in the list of topics. The user thus has a visual representation of which sections of the module he or she has examined, and which have not yet been examined. Initial pilot testing indicates that inexperienced users find this feature particularly helpful.

The History of CIS. A master display, in time-line format, presented a summary and overview of the history of CIS. A user can investigate a specific phase of the history by pointing at the segment of the time-line representing that phase. For example, if the user points at the Discovery Phase, the display changes to additional screens which present textual and visual information about the staff and clients of the street academies, statistical information about the number, dates, and funding of the street academies, a chronology of the expansion of street academies to additional cities, and other material.

Other segments, in an interactive manner, allow the user to explore the other phases in the history of Cities in Schools (Development, Demonstration, Refining and Expansion, and National Training).

The CIS Organization. The module opens with an animated map of the United States which illustrates the national and regional organizational structure of Cities in Schools. The master navigation buttons along the bottom of the screen include Overview, Objectives, National Organization, Regional Organization, and Local Organization.

For each segment of the organization, the primary personnel are identified, along with their job responsibilities and their relationships with other personnel. Photographs of each member of the National Board of Directors are included, along with brief biographical sketches. Where available, photographs of current Cities in Schools staff were included. The proposed National Training Institute, a joint effort of Cities in Schools, Inc. the Iacocca Institute at Lehigh

University, and the College of Education at Lehigh University, is also described.

The CIS Replication Process. This module opens with a map of the United States, upon which an animated series of CIS flags appear to represent new Cities in Schools programs being developed. The major navigational buttons on the bottom of each screen include: Overview, Objectives, Browse, Self-Check, and the major phases of the replication process itself (Pre-Implementation, Implementation, and Ongoing Support). For each major phase, the user is presented with an overview screen which contains additional buttons providing increasing levels of detail about each major phase, its objectives, and the personnel and procedures involved in that phase.

## ADVANTAGES OF USING HYPERMEDIA FOR TRAINING

Hypermedia applications provide a complex and potentially powerful delivery system utilizing the strengths of computers combined with the illustrative power of other media. Several key features of hypermedia provide special advantages (as well as challenges) for the developers of training materials. Several of these features will now be discussed.

First, hypermedia is a computer-controlled medium. All of the power and flexibility inherent in traditional computer-based materials are available in hypermedia applications. Second, hypermedia is a nonsequential medium. Thus, users are able to utilize the material in the order in which such use makes sense to them. Obtaining the full benefit of hypermedia, however, may require additional training support for users who are acculturated to a traditional, linear "book" technology. Third, hypermedia is a multimedia technology, with the potential to make effective use of computer-generated text and graphics, videotape, videodisc, slides and photographs, audio materials, and other materials. Multimedia materials should benefit all learners, particularly visual learners. The training materials can be made less dependent on the learner's having high reading skills. And presentation in a variety of formats will add to the overall interest of the materials presented.

In addition to these features, hypermedia is a new medium in its own right. Hypermedia is so relatively new that instructional designers and media researchers are just beginning to understand how hypermedia applications can most effectively be organized, and what impact the special features of hypermedia not hitherto available have on learning style and learning effectiveness. It is hoped that the experience of the Cities in Schools Hypermedia Curriculum Project will contribute to the development of the understanding of the creative and effective uses of hypermedia.

## PHASE TWO OF THE CITIES IN SCHOOLS HYPERMEDIA PROJECT

The experiences gained in developing the Phase One Cities in Schools hypermedia materials and preliminary results of their use in actual training have demonstrated the value of the approach taken. Two additional factors have influenced the future direction of the project. First, it was felt both by Cities in Schools staff and the hypermedia development team that two of the primary objectives of Cities in Schools training were to convey the philosophy of Cities in Schools and to develop an emotional as well as intellectual commitment to its goals. This philosophy embodies a commitment to decentralization and local community control. Cities in Schools is described by William Milliken, its president and one of its founders, as "a mission in the process of becoming a program." (Milliken, 1989). It was felt that motion video was necessary in order to convey the philosophy effectively and to promote the desired commitment. The second influencing factor is that Cities in Schools has, since its inception, made extensive use of videotape in documenting its programs and in disseminating information about them. Thus, a considerable amount of videotape materials about the program already existed.

For these and other reasons, it was decided that the next phase of the Cities in Schools hypermedia project would involve the redesign of the entire training curriculum as a hypermedia-based curriculum integrated with print materials. The proposed curriculum will utilize the full range of multimedia materials, including motion video.

Plans for the next phase of the project are now being formulated. Current plans call for a year-long project beginning in August, 1989. A complete review of the Phase One curriculum materials will be conducted, and an overall plan for the goals, scope, instructional approach, and general philosophy of the integrated hypermedia curriculum will be developed, along with a list of available print, photographic, and video resources which might be included. A version of the complete curriculum, including all types of media except motion video, will be completed by January, 1990. During the spring of 1990, additional video materials will be produced. These will be combined with existing video materials and transferred to interactive videodisc. At the same time the hypermedia software will be rewritten to integrate the videodisc materials into the overall curriculum. The complete curriculum will be completed and tested during the summer of 1990 at the proposed Cities in Schools National Training Institute jointly sponsored by the Iacocca Institute and the College of Education at Lehigh University.

Current plans call for the use of Macintosh IIcx microcomputers and Pioneer videodisc players as the hardware environment. This will provide a powerful computer system with full color, good screen resolution, and tested interfaces between the computer and videodisc systems. Analog videodiscs (rather than DVI or other versions of digital video) will be utilized because they represent a known technology with proven abilities, and because the delivery systems for products developed are available and cost-effective. Hypermedia software being evaluated include ColorCard (Academic Courseware Exchange, 1989), and SuperCard (Silicon Beach Software, 1989).

## CONCLUSION

The Cities in Schools program addresses critical social needs. It is growing rapidly, and therefore effective and efficient training of new staff and other persons involved in CIS is needed. At the same time such training must convey the spirit of Cities in Schools as well as concepts, facts, and skills. A hypermedia-based integrated print and videodisc training curriculum will provide such training and thus contribute to solutions for the critical social problems facing our country.

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# CD-ROM TUTORIAL: TRAINING FOR A NEW TECHNOLOGY

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## ABSTRACT

A computer-based education program has been developed at the University of Central Florida to train educators and students in the use of CD-ROM technology. The training covers an overview of CD-ROM storage technology, an introduction to search strategies, a simulation of a CD-ROM program, and a list of available applications. The tutorial was developed for delivery in three different operating systems. This paper addresses the need for the project, as well as the design, development, and evaluation procedures.

## INTRODUCTION

Educators have discovered a powerful tool in the use of Compact Disc-Read Only Memory (CD-ROM). This technology is capable of storing large quantities of information at relatively low cost. In fact, one CD-ROM disc can store approximately 1000 times the amount of data as a floppy disk, and the price of a CD-ROM drive is now falling to below $500.00 (Lancaster, 1989).

Since its conception five years ago, CD-ROM has grown from an interesting novelty to a major publication medium. It is conservatively predicted that in 1989 both the installed base of drives and the number of available CD-ROM titles will double (Herther, 1989). Current applications of this new technology are primarily geared toward research and are tremendous resources for university libraries and school media centers. However, because special hardware is required, it is difficult for many educators and students to preview CD-ROM materials or see its power demonstrated.

## THE SITUATION AND THE NEED

The Florida Department of Education (DOE) funds four Instructional Computing Resource Centers, one of which is located at the University of Central Florida (UCF) in Orlando, Florida. The UCF Center has been providing information to Florida educators about computers and computer literacy for several years and recently has expanded the scope of its activities to include information about new and emerging technologies for instruction and information management.

The UCF Center works through an established "Instructional Computing Contact Network" (ICCs) comprised of one key person in every Florida school district, community college, college of education, exceptional education center, and the State's five Centers for Excellence in Science, Mathematics and Computer Technology. In the fall of 1988, a survey was conducted of the ICCs and the district media supervisors to determine the status of CD-ROM use and information. In addition to determining what currently existed in the schools, school districts and community colleges, contacts were queried as to what kinds of information and services they would find helpful in relation to this new technology.

The survey results indicate that CD-ROM is being used primarily at the district level, where large databases assist in library media acquisition and processing. In several districts, CD-ROM technology holds the massive number of lessons delivered by integrated learning systems. Finally, in very limited numbers, CD-ROM resources are used in community college libraries and school media centers for research and reference.

The survey also revealed that school level educators were less aware of the technologies than media specialists and instructional computing contacts. It was concluded that a great deal of information and training would be necessary to promote the acquisition and implementation of CD-ROM technology.

The need for a vehicle to disseminate this information led to the selection of a computer-based education (CBE) program as the best format to introduce educators and students to CD-ROM. CBE adapts well to a wide range of learner characteristics and allows for individual sequencing, self-paced instruction, and immediate feedback. The resulting program was designed for use by educators as well as students in grades seven and above and includes the following topics:

1. Definition of CD-ROM and how it operates
2. Description of how to search for information using retrieval software
3. Demonstration/simulation of a CD-ROM application
4. Information on available CD-ROM applications

## DESIGN

The topics were divided into four major categories, which became the Main Menu choices (see Figure 1). The Main Menu was designed to be prominent and distinct from all of the other menus in order to avoid any confusion by the users. Students may choose the Main Menu selections in any order, repeat them if they wish, and exit at any time. Throughout the program maximum learner control is provided with permanent options such as Back, Exit, Return to Menu, and Continue.

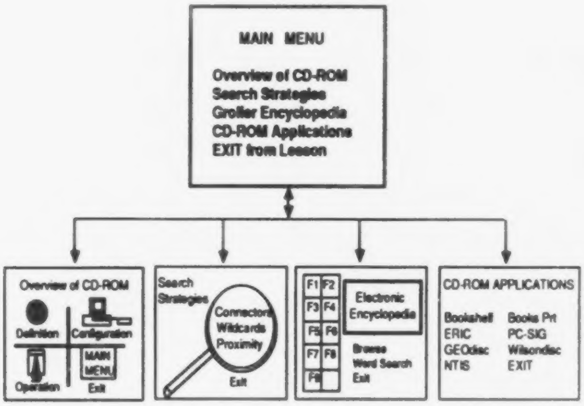

Figure 1. Main Menu of Tutorial

### Overview of CD-ROM

The "Overview of CD-ROM" section defines CD-ROM technology, illustrates the required configuration, and provides an explanation of how CD-ROM discs are read. Menu selections are short (3 or 4 screens), followed by an optional question screen and appropriate feedback. Because the program is designed as an overview rather than a tutorial/test program, there is no management system. This method allows the users to skip the questions if they wish.

### Search Strategies

The "Search Strategies" section addresses techniques used to search for and retrieve information. The techniques demonstrated (logical connectors, wildcards, and proximity searches) are used in CD-ROM applications and are also applied to on-line information retrieval. This branch of the program introduces the concepts of search techniques, emphasizing that different databases employ slightly different commands. The techniques are demonstrated and practice exercises are provided.

### Grolier Encyclopedia™

Because an actual demonstration of a CD-ROM application was not possible in most schools, a CD-ROM simulation was provided as a part of the CBE program. In the MS-DOS® version, this section provides a simulation of the CD-ROM *Grolier Electronic Encyclopedia*. It is designed to acquaint the learner with the operation and features of the Grolier CD-ROM without the necessary hardware. The user can choose to Browse or perform a Word Search for the word PANDA. Windows are incorporated over replications of the Knowledge Retrieval System™ (the search software program) and the Grolier screens to provide instruction and explanations.

### CD-ROM Applications

The "CD-ROM Applications" section includes a listing of the names and subject areas of several of the available CD-ROM applications. The addresses and telephone numbers of the publishers are provided for those seeking further information. This section is intentionally listed as the last menu choice. At this point in the lesson, media specialists and other educators should be able to make decisions about which applications would be appropriate for their school to acquire.

## DEVELOPMENT

### MS-DOS Version

The course was initially developed for delivery on an IBM® or compatible computer because most of the CD-ROM products were configured for MS-DOS environments. A minimum of a color graphics adaptor (CGA) card is required with a color monitor and 256K of RAM.

The authoring system chosen for this development was the TenCORE® Authoring Language by Computer Teaching Corporation. TenCORE provides the required windowing capabilities, flexibility, response analysis, and graphics. Another advantage of TenCORE is that the entire lesson, along with the execution files, will fit on one diskette.

In order to incorporate the necessary graphics, the majority of the program was developed in the graphics mode. This limited the color selection to one of two color palettes and limited the text to 40 columns. In order to provide consistency, a blue background was used throughout the course with white text and magenta highlights for keywords.

TenCORE provides a text and graphics editor which simplifies the creation of most text and graphics screens. More intricate graphics (such as the map of the state of Florida) were created in PC Illustrator®, captured with the Frieze™ program of PCPaintbrush® and imported into a TenCORE image unit. Because the image units generally require more disk storage space than other units, their use was kept to a minimum.

To accurately simulate the Grolier Electronic Encyclopedia and the Knowledge Retrieval System (KRS) screens, the 80 column text mode was required. In this mode, with a CGA card, there are 8 available colors. A program that would allow the importation of the text screens from KRS was not available; therefore, the screens were recreated in TenCORE. The screens were replicated to the maximum extent possible, although slight changes were necessary for instructional benefit.

### Macintosh Version

The second development effort focused on the Macintosh™ environment. HyperCard™ was chosen as the authoring tool because of the ease of authoring and incorporating graphics. In order to run the Hypercard application, a Macintosh computer with approximately one megabyte of memory and the HyperCard program are needed.

Although the same basic design (as the MS-DOS version) was incorporated, some changes were required. Instead of colors, shades and patterns had to be used to designate the functional screen areas. Graphics were easier to incorporate and were added where appropriate. Basic program branching was completed with the Hypercard "buttons," and HyperTalk was utilized for answer analysis and complex programming.

Permission was obtained to simulate the Macintosh version of *Facts On File News Digest* ® for the simulation portion of the program. Fact on File is a reference tool that contains all the basic facts of U. S. and world news for the years 1980 through 1987. It provides quick information on science, sports, celebrities, obituaries, currrent best sellers, and film and theater openings. More than 500 maps of the U. S., Canada, Europe, and the rest of the world are also included.

### Apple II Version

The program is currently being developed for the Apple™ II computers using the Tutor-Tech™ Authoring System Version 2.3 by Techware, Inc. This authoring system requires 128K of RAM, a mouse, and an 80-column card, and it provides graphics and text fields with each frame. It also includes the ability to place buttons on the frames that will keep score and branch to another screen. Lessons produced on Tutor-Tech can be delivered on any 128K Apple II computer; the learner's disk is self-booting and does not require a mouse.

There are very few CD-ROM applications available for the Apple II computers. A search is underway to select an appropriate application to simulate and then to secure the permission to do so.

## EVALUATION

The effectiveness of the CD-ROM tutorial was evaluated by students at the University of Central Florida with a criterion-referenced pretest and posttest. The students in seven undergraduate classes were randomly divided into two groups. One group served as the comparison and were given a pretest followed in thirty minutes by a posttest. The second group took the pretest, then received the CBE treatment (tutorial) . A posttest was administered immediately after the treatment. The pretest and posttest consisted of twenty mutiple choice questions.

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The results indicate that there was a significant increase between pretest and posttest scores for the group receiving the treatment. The mean achievement and the standard deviation scores are given in Figure 2 for both the comparison group and the treatment group. While the scores for the treatment group increased significantly between the pretest and posttest, the scores for the comparison group decreased slightly. This decrease was attributed to the students' lack of interests as they (the comparison group) had just taken the similar pretest.

| | **Pretest** Mean (S.D.) | **Posttest** Mean (S.D.) |
|---|---|---|
| **Comparison** | 1.3 (2.1) | .8 (1.5) |
| **Treatment** | 1.5 (2.4) | 15.1 (3.1) |

Figure 2. Mean Achievements

In addition to the pretest and posttest, an evaluation form was distributed to the treatment group to ascertain student attitudes about the CBE program. In the evaluation, 95% of the students said they had enjoyed the program. Typical comments on specific ways that the computer-based delivery format of this lesson aided in their learning are summarized as follows: students liked the "hands on" capabilities; they enjoyed being able to go "back" and "review"; they felt the program was "user friendly"; and they liked being able to move through the program at their own pace. The students enjoyed the "Overview" and "Grolier Simulation" sections most and liked the "Applications" section least.

## DISTRIBUTION

The program is being disseminated to all schools in the State of Florida free of charge by the UCF/DOE Instructional Computing Resource Center through the Instructional Computing Contact Network. In conjunction with this effort, additional funding has been secured to provide CD-ROM players and programs to 15 selected middle and high schools in Central Florida. Research will be conducted with these schools to determine the optimal uses and training for CD-ROM. The CD-ROM tutorial program has been used successfully with teachers and media specialists participating in this project. They, in turn, will use the program with their own faculty and students.

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# Authoring in the Jefferson Notebook

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## Abstract

The Jefferson Notebook was originally developed at the University of Southern California as a learning support environment for freshman students working on writing assignments using the U.S. Constitution as a content area. In this paper, the main features of the notebook are described along with recent extensions that make it a more general tool for authoring courseware. The knowledge engineering requirements of learning support environments and the need for explicit interaction models are also discussed.

## Introduction

Project Jefferson has two major goals (Chignell and Lacy, 1988): 1) to develop an effective model of computer-based instruction that includes the use of research tools and a standard interface that can act as the front end for courseware across a variety of different disciplines; 2) to develop a researcher's notebook that will permit easy access to online information. The Jefferson Notebook is a software tool that has been developed in order to achieve these goals.

The Jefferson Notebook has been under development since the beginning of 1987 as part of the larger project to develop academic courseware that integrates research and instruction. The software tools developed in the notebook, and to some extent even the goals of the project, have evolved over time as we have learned from our research. Earlier progress in the project has been described elsewhere (Kinnell and Chignell, 1987; Chignell, 1987; Chignell and Lacy, 1988).

The goal in this paper is to describe the major characteristics of the Jefferson Notebook and to place that work within the broader context of developing hypermedia authoring capabilities generally. We will focus here on the functionality of the Jefferson Notebook and the specific requirements of courseware applications. General issues relating to the usability of hypermedia applications (which also apply to courseware environments such as the Jefferson Notebook) are discussed elsewhere (Waterworth and Chignell, 1989). In the following section we describe the current features and functionality of the Jefferson Notebook Version 1.0. Those interested in acquiring a copy of the Jefferson Notebook should contact Richard Lacy at the Center for Scholarly Technology, University of Southern California.

## The Jefferson Notebook

The Jefferson Notebook (Figure 1) represents the current implementation of ongoing research into integrated research and instructional environments for academic computing. It consists of three information containers or resources, namely the notebook, the encyclopedia, and the citations. A fourth resource (USCInfo, that allows students to access BRS online databases located on the USC mainframe through the Jefferson notebook) is currently available only at the University of Southern California. The Jefferson Notebook is written as a set of HyperCard stacks on the Apple Macintosh microcomputer, with associated subroutines (X-CMDs) written in C.

The notebook is the place where information is stored and organized. It may be thought of as a combined personal database and work area. The information within the notebook may either be created as notes by the user, or photographed from the cards available in other information resources represented as other HyperCard stacks that may be accessed from the Notebook. However, all the information, regardless of its source, ultimately ends up as notelike cards in the notebook.

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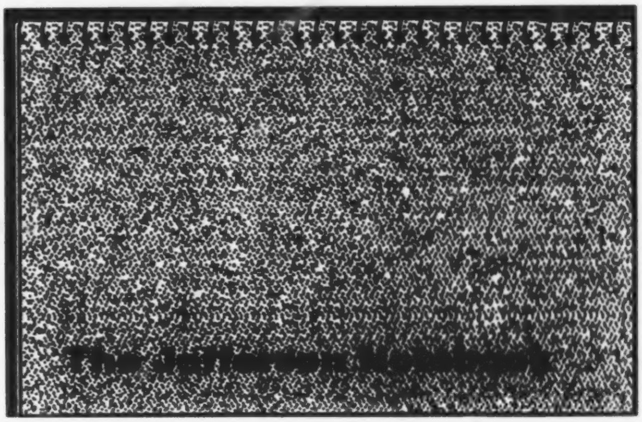


Figure 1. The Jefferson Notebook

The Jefferson notebook is called by clicking on the notebook icon (shown in the upper right of Figure 2). The environments represented by the tabs (shown at the bottom of Figure 2) are regions of the notebook that specify assignments, store an evolving written paper, or provide a buffer for storing information prior to structuring and organizing it within the paper.

## Assignments

Assignments (Figure 2) provide the initial information for using the Jefferson notebook. The notebook is envisaged as a tool for exploring information and ultimately writing a document that includes the results of this exploration.

The Jefferson notebook already has a number of built-in assignments that users (typically students) may work on. In the authoring version of the notebook, users (such as teachers) can build their own assignments either for a class or to define the goals of customized research tasks that they may wish to perform.

## The Encyclopedia

The assignment is the first section of the notebook. However, before working with the other notebook sections, the user will generally carry out some research so as to find information that may be used in preparing a document. One of the available information resources is the encyclopedia.

The encyclopedia consists of an associative (hypertext) network of information represented in the form of cards. It will generally be tailored to the current task and thus will need to be separately authored for different courseware content areas. Each card in the encyclopedia (e.g., Figure 3) has a title, and the author or authors of the information are shown in the lower left corner of the card. The authorship for cards that were specifically written by the Project Jefferson team is denoted as the Project Research Team, with the year when it was written.

The *Remember this Term* button at the bottom of the screen shown in Figure 3 allows the user to add the current term to a set of interesting terms that may later be referred to, much as one might dog-ear a page in a book for later reference, or highlight a passage of text.

The camera icon shown at the bottom of Figure 3 allows information to be stored into the saved information section of the notebook. When the icon is selected the user is asked if he wants to input the information into a special category. If not, the information is automatically stored into the Sources category of the saved information.

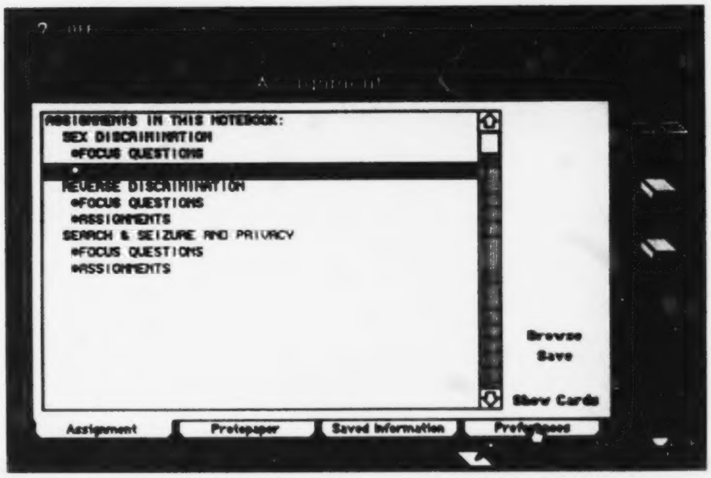
The *To Other Terms* button provides a number of browsing tools within the hypermedia network of information. These browsing tools are made available within a pop-up menu. They include an alphabetical listing of the information cards available, a list of previously remembered terms which the user can jump back to, a list of more specific or more general information that can be moved to, and a set of related terms that function as general associative links in the hypermedia. These browsing tools allow each node in the encyclopedia to be viewed both as part of a network and as part of one or more hierarchies.

When users have finished with the encyclopedia they simply click on one of the other resources which then closes the encyclopedia and opens the other resource.

## Citations

The citation information resource provides a built-in database and information retrieval system. Like the encyclopedia, it will generally be tailored to a particular courseware application. The opening screen of the Citations container consists of three windows (Figure 4). In the left window is an alphabetical listing of searchable topics within the system. Access to specific terms within this listing is speeded up by use of an alphabetic region selector. If the user clicks the A to I button, the first third of the alphabet is shown, clicking the J to R button shows the second third of the alphabet, and so on.

Once a relevant term is found it may be selected by clicking on it with the mouse. The term is then added to the upper right hand window which represents the current query. The terms in the query box (upper right window) are then logically ANDed together and a set of relevant citations is constructed of documents that contain all of the index terms specified within the query window.



ASSIGNMENTS IN THIS NOTEBOOK:
SEX DISCRIMINATION
•FOCUS QUESTIONS
•
REVERSE DISCRIMINATION
•FOCUS QUESTIONS
•ASSIGNMENTS
SEARCH & SEIZURE AND PRIVACY
•FOCUS QUESTIONS
•ASSIGNMENTS

Figure 2. The Assignment Section of the Jefferson Notebook

The third window in the lower right hand corner of the card shows the number of document that have been retrieved for the current query and also contains two buttons represented by the horizontal rectangles.

The *view citations* button allows the user to browse through the stack of citations retrieved using the current query, while the *new query* button allows the user to remove the terms used in the current query and start afresh. This has the effect of making all documents in the citation database available within the stack of citations.

When viewing the citations, the user may store information into the notebook either by photographing the citations directly or else by making a note describing reactions to the content of the citation. If a citation is photographed it is automatically stored into the citations section of the saved information within the user's notebook, unless the user specifies otherwise when the dialog box appears after the camera tool is selected.

Viewing citations in the stack of citations leads to a standard Jefferson citation card (Figure 5). This card format is also used in versions of the Jefferson system that download citation information from online databases such as the BRS retrieval system at the University of Southern California.

The identity of the current information resource is typically indicated in the top left hand corner of the card, immediately below the help icons, and for the citations container this is shown by the italicized word "citations." The type of citation is shown in the top right hand corner of the card.

At the bottom of the basic citation card are three italicized buttons. The *index of all terms* button allows the user to view all the available index terms, while the *citation's index terms* shows the index terms for the particular citation being viewed. These index terms will generally include the terms referred to in the search query along with other terms that do not appear in the search query. The third italicized button is the *abstract*. When it is selected, the abstract for the document appears as a pop-up window. Each of the three italicized buttons in the bottom of the card act as toggles. Thus, to make the corresponding windows disappear after they have been selected, one simply presses the italicized button again.

The two rectanguiar buttons, *sort*, and *change query*, respectively, provide additional functionality. The Sort button allows the user to sort the citation stack by either author or title, while the change query button returns the user to the top level citation screen which has the three windows for entering terms into the search query and viewing the number of citations retrieved.

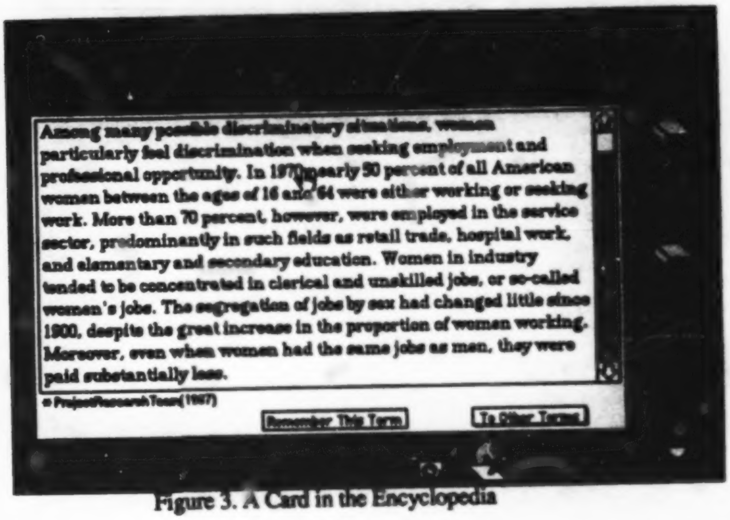
The other icons that appear around the border of each citation card are common to the other resources within the Jefferson model. These include the arrow navigation buttons, the camera and notetaking icons, the help icons, the quit icon, and the information containers. One of the features of the Jefferson model is that the border of the screen consists of a standard set of icons that are shared throughout the Jefferson system, having a similar appearance and functionality in each of the components of the system.

The detailed information inside each citation card consists of textual information. Apart from the italicized buttons, at the bottom of each citation, the citation itself does not contain selectable buttons. It is not part of the current Jefferson model for buttons to be opportunistically embedded within text since this tends to act against the standard appearance of the Jefferson interface that we are striving for. However, many hypermedia systems do allow hotspots to be embedded within text, the Intermedia system being a notable exception (Kahn and Meyrowitz, 1988).

### Notetaking

The notetaking tool can be reached from most screens in the Jefferson notebook and is selecting by clicking on the notetaking icon, which appears as a pencil poised over a piece of paper. This icon appears in the lower right portion of the screen.

Once the notetaking tool is selected a pop-up menu appears. However, the user must hold the mouse button down for the menu to appear and remain on the screen. As soon as the mouse button is released the pop-up menu will disappear. The user makes his selection by holding the mouse button down until the menu appears, moving the mouse over the option of interest, and then raising the mouse button. The notetaking



Among many possible discriminatory situations, women particularly feel discrimination when seeking employment and professional opportunity. In 1970, nearly 50 percent of all American women between the ages of 16 and 64 were either working or seeking work. More than 70 percent, however, were employed in the service sector, predominantly in such fields as retail trade, hospital work, and elementary and secondary education. Women in industry tended to be concentrated in clerical and unskilled jobs, or so-called women's jobs. The segregation of jobs by sex had changed little since 1900, despite the great increase in the proportion of women working. Moreover, even when women had the same jobs as men, they were paid substantially less.

Figure 3. A Card in the Encyclopedia

menu gives the user the choice of writing a new note or editing an existing note. The titles of existing notes are shown in the menu.

After a note has been written, it may be browsed or edited. There are two basic methods for editing existing notes. The first method is to reopen the note by selecting the notetaking tool and then choosing the title of the note one wants to edit from the note menu. One can then get in and change the text of the note using the standard word processing features of the note taking tool. However, the preferred method is to go to the saved information section of the notebook, select a note, and then click on the browse tool. This then displays the note as a standard card within the notebook. This card can be edited using the same tools as in the notetaking tool (including cut, copy, and paste), the only difference being that the note window cannot be resized or moved around the screen. When one has finished editing the note one clicks on the up arrow at the bottom of the screen and the system returns to the saved information card.

## Working within the Notebook

Once notes have been written and information has been photographed from the available information resources, the resulting text is stored in the saved information section of the notebook. The saved information section acts as a buffer for information that has been collected but not yet incorporated into the structure of a document. In order to use it within an evolving document, information is first photographed and stored in the saved information and is then transferred into the draft of the document (referred to as the protopaper in the Jefferson Notebook, as shown in Figure 1) using copy and paste tools. After notes are saved, they too become part of the saved information and can be pasted into the protopaper in the same way.

There are a number of outlining tools that are available in several of the environments of the notebook. In fact the main difference between the authoring and non-authoring versions of the notebook resource of the Jefferson Notebook is the number of outlining tools that are available, particularly the copy, paste, and delete tools.

In the protopaper section of the notebook, the *new level* tool allows the user to add a new category to the outline. The user is prompted for a name for the new category, which is then placed beneath the current level, at the end of the other children of that category. For instance, imagine that the protopaper has a top level category called main level which has two children, namely introduction and exposition. If one now adds a new level called summary while at the main level, the summary will then be added beneath the main level, after the exposition. The *new level* tool is also available in the saved information environment, so that the user may add new categories. The default information categories used in the Jefferson notebook are sources, notes, and citations. Unlike the protopaper environment, though, saved information categories are not nested into tree structures.

The *promote* tool raises a category one level higher in the structure. For instance, if summary has a sublevel called the main point, this sublevel could be promoted using this tool so that it was at the same level as the summary. Promoting a level has the visual effect of moving the level to the left on the screen.

The *demote* tool is the inverse of the promote tool and moves a category to the right of the screen. The demote tool only works if there is a lower level available to demote to. Generally, the demote tool works by shifting the category referenced directly to the right. This has the effect of nesting it within the category which had previously preceded it, but at the same level. For instance, if we had introduction and exposition nested beneath the main level and we demoted exposition, it would then be nested beneath the introduction.

*Move up* reverses the position of the current category and the previous category that is at the same level. Any categories that are nested within the current category are also moved so that the pattern of nesting remains unchanged.

*Move down* is similar to move up except that it reverses the position of the current category and the following (instead of previous) category that is at the same level.

In the student version of the notebook the outlining tools are generally disabled in the assignments section so that students cannot modify assignments. However, the full outlining features are available in the saved information and protopaper sections of the student notebook.

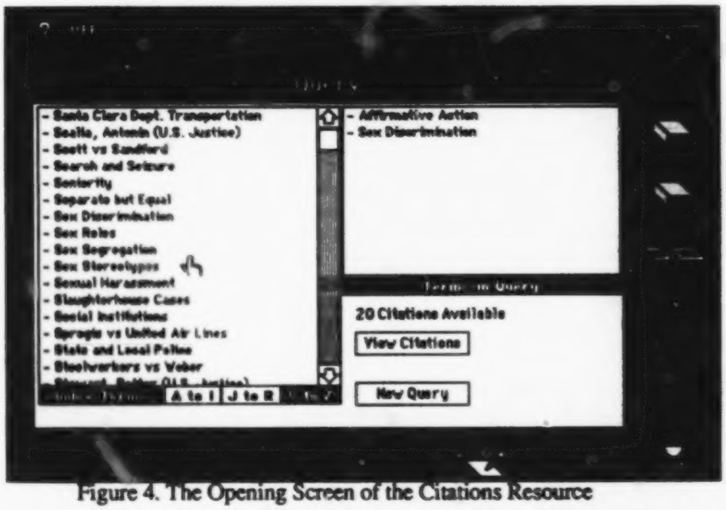


Figure 4. The Opening Screen of the Citations Resource

The *browse* tool allows one to view the saved information in a convenient way. Browsing may also be carried out in the assignment and protopaper sections of the notebook. The behavior of the browser depends on how one selects it. One begins by marking a portion of the saved information to be browsed. This portion may consist either of a single note, citation, or piece of information, or it may consist of a category. When it is a category, and the browse tool is selected, all the cards in the category are formed into a stack. The user is taken to the first card in this stack. The user may browse through this stack using the *navigation arrows* that appear below the lower left portion of the notebook. The inner left and right arrows move the user one card backward and forward in the stack, respectively. The smaller outer arrows go to the beginning and end of the stack respectively. The up arrow returns the user to the saved information screen. The counter in the bar at the middle of the screen shows the user the size of the stack and the position of the card currently being viewed. The user may then jump to a specific card number in the stack by clicking on the counter box and inserting the required number into the dialog box that then appears.

## The Authoring Version of the Jefferson Notebook

In addition to acting as a personal database, the Jefferson Notebook also functions as a document preparation kit or shell. The Project Jefferson Team has designed a set of authoring tools that allow users to build new notebooks and link them to information resources that are appropriate for their application. We may divide the authoring task into citation authoring, encyclopedia authoring, and notebook authoring tasks. Citation authoring consists of four major tasks.

1. Selecting Documents - The research model built into the Jefferson Notebook requires the availability of a set of secondary sources on the topic of the courseware application. These sources could be books, journals, hand-outs, or some combination thereof.

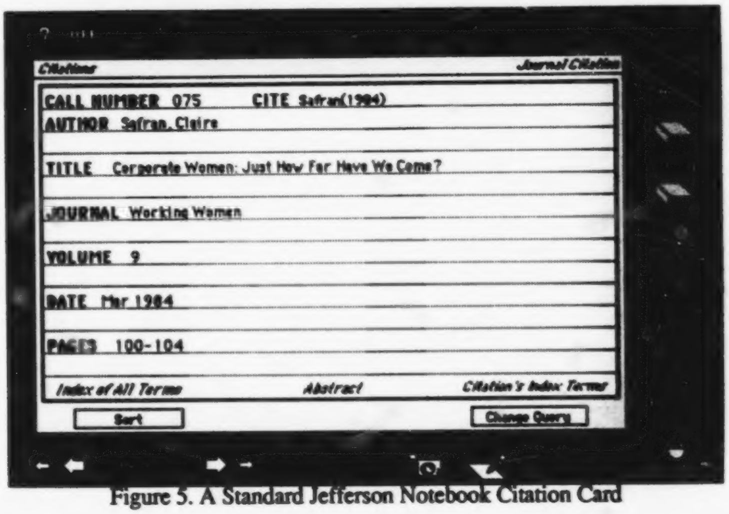
2. Constucting the Index - The developer first identifies the relevant index terms for the topic and then builds a hierarchy of these index terms. Identification of index terms is often facilitated by consulted the indexes of various standard references on the topic. It is important, however, to ensure that the terminology used in the index is appropriate for the target user population for the courseware application.

3. Indexing - The task of indexing is a critical part of Jefferson Notebook authoring, and is generally the most time consuming task for the developer unless she is fortunate enough to have an appropriate set of indexed articles already available. In general, the documents should be indexed with between three and seven of the index terms that best represent their content. Care should be taken to ensure that index terms are applied consistently. More information on indexing may be obtained by consulting a standard reference on indexing.

4. Preparation of Jefferson Format Files - The loading of a citation database into a Jefferson Notebook application is generally a batch process. Prior to loading the citations into a Jefferson Notebook, the citation for each document is entered into a text file in a specific format.

Construction of the encyclopedia for a Jefferson Notebook application requires two main tasks: creating the text for each entry in the encyclopedia; linking entries within the encyclopedia. Each encyclopedia entry is created within a text file which is then loaded into the notebook using the authoring tool (in a batch process). Links may be created in one of two ways: 1) automatically, by calculating links based on co-occurrences of terms that are typically assigned to the same document; 2) manually, by specifying the two endpoints of each link, as done in most hypertext systems. Hierarchical links are assigned based on the hierarchical index defined by the developer as part of the process of building the index for the citation database.

Notebook authoring is simply an extension of regular notebook activities. In fact, the student version of the notebook is basically the authoring version of the notebook with a few critical card creating functions eliminated from the Assignment section of the notebook. For instance, in the protopaper section it is possible to paste in notes or information and to reorganize the hierarchical order of subsections within the protopaper.



CALL NUMBER 075 CITE Safran(1984)
AUTHOR Safran, Claire
TITLE Corporate Women: Just How Far Have We Come?
JOURNAL Working Women
VOLUME 9
DATE Mar 1984
PAGES 100-104

Figure 5. A Standard Jefferson Notebook Citation Card

These same features, when available in the Assignment section allow one to define assignments by writing them as notes and then pasting them into the assignment section. One may also organize the order of assignments and subassignments by using the outlining tools. Thus the authoring version of the notebook permits new assignments to be constructed as one would construct a protopaper.

## Knowledge Engineering and Authoring of Hypermedia-Based Courseware

The authoring tools now available within the Jefferson Notebook make it a shell for developing courseware applications. Those familiar with the development of expert systems (Parsaye and Chignell, 1988) will find an analogy here between the use of the Jefferson Notebook to develop courseware applications and the use of an expert system shell to develop an expert system. However, in contrast to expert systems, where the goal is to apply expertise to solve problems and make decisions, in courseware development the goal is generally one of creating an environment that supports learning. This requires both the selection and editing of information resources, the setting of instructional goals, and the development of interaction models that achieve the instructional goals through the utilization of the information resources.

The Project Jefferson model of knowledge engineering of information resources includes the acquisition of direct (as in the notes used in the encyclopedia) and indirect (as in citations to information contained in documents) information, along with the representation of knowledge as associatively linked information and representation of key concepts within index hierarchies which themselves represent an alternative linking structure. In our knowledge engineering process we have used traditional library research methods to select indirect information and sorting tasks to select and hierarchically organize index terms, which are then expanded into encyclopedic notes. An indexing hierarchy may be constructed with a sorting task, using the following method. The developer, and perhaps other content area specialists, take a set of cards (where each card represents one of the identified index terms) and groups them into piles according to which terms belong together. Each resulting pile is then labeled by an appropriate aggregate index term (representing the common concept shared by the index terms in the pile) and the aggregate index terms are then organized into piles. This process continues until a complete hierarchical structure is formed.

Other aspects of the courseware knowledge engineering process, i.e., the setting of instructional goals, and the development of interaction models that achieve the instructional goals, have yet to be addressed in our ongoing project. The authoring of instructional goals is more properly a topic for the courseware content developers than it is for shell developers such as ourselves who are more concerned with the development of generalized authoring environments. However, the interaction model represents an important new area that needs to be addressed by research teams that are interested in the development of advanced computer-based instructional and learning support environments. We are currently reviewing alternative interaction models, including goal-oriented approaches that use a mixture of questioning and information presentation to move students through a network of knowledge states towards specific instructional goals. This latter approach was inspired by analysis of Socratic dialogues as reported by Plato (1987).

Even without explicit interaction models, the availability of authoring tools within the Jefferson Notebook now makes it possible for a wide range of courseware applications to be developed within the model of integrated research and instruction that has so far yielded promising results at the University of Southern California. In our view, the development of hypermedia-based courseware authoring shells represents an exciting new frontier for work in computer-based instruction and learning support.

## Conclusions

Courseware development environments have evolved from early systems that were little more than text editors to modern systems that implement complex instructional models. Authoring for hypermedia-based courseware creates special challenges. In this paper we have described the basic properties of the Jefferson Notebook as an integrated research and instructional environment for learning support. Due to its modular design and its tools for information collection and management, it has been fairly straightforward to extend the Jefferson Notebook to a more general courseware authoring environment. However, challenges remain in the knowledge engineering of hypermedia-based courseware environments. In particular, interaction models are needed that can capitalize on the flexible nature of hypermedia and the functionality of ancillary tools such as notetakers, embedded citation databases, and outliners.

## Acknowledgements

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# A Mindtools Curriculum for Pre-Service Teachers

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## Focus of Model: Mindtools: Liberating Intellectual Forces

Recent developmental efforts in artifical intelligence, object-oriented programming, and the integration of learning theory into the design of computer-based learning environments have fostered the growth of a new genre of cognitive tools. In some cases, these tools represent new software environments, and in other cases, a reconceptualization of how to use existing utilities, such as databases and spread sheets, to enhance intellectual growth. This combination represents the newest generation of mind-expanding environments. These environments are potential liberating intellectual forces. However, these tools may be used for expanding minds.

Like all tools, when these tools are used for their prescribed tasks in prescribed ways, their power is finite. In this mode, the relationship between the learner and the computer is reactive. When elements of user control are added, the relationship becomes interactive. The learner derives more satisfaction and accomplishment from the interaction, but the learner is still constrained by the expectations of the software. What then makes a tool mind-expanding?

A tool becomes mind-expanding when it is novel or is used in novel and creative ways for new and unprescribed purposes--when the relationship between the user and the computer becomes generative (Jonassen, 1988b). Tools are mind expanding when they foster and enable critical thinking. Environments are now available which can be used to enable those thought processes.

## Focus of Model: Cognitive Learning Strategies

Researchers (Tessmer & Jonassen, 1988) have argued for the explicit teaching of cognitive learning strategies or the embedding of those strategies into computer environments to foster deeper, more meaningful thinking. Cognitive learning strategies are mental operations that the learner may use to acquire, retain and retrieve different kinds of knowledge or performance. Cognitive learning strategies are generative. They enable learners to take an active, constructive role in generating meaning for information by accessing and applying prior knowledge to new material. Merle Wittrock's generative hypothesis asserts that meaning for material presented by computer or any other medium is generated by activating and altering existing knowledge structures in order to interpret what is presented. Learning strategies are intended to increase the number of links between presented information and existing knowledge. The amended structures are then encoded into memory as distinctive features that may later be accessed to explain and interpret new information. The complex cognitive transformations and elaborations involved in this process may be fostered by specific cognitive learning srategies. Examples of these strategies include paraphrasing, creating images, generating questions, cognitive mapping, comparison-contrasts, and so on. In these activities, information is transformed and elaborated to make it more meaningful for the learner.

Jonassen (1988a) has classified cognitive learning strategies into primary and support strategies. Primary strategies are those information processing strategies that directly affect the way the learner processes information. These include integration, recall, organizational, and elaborational strategies. Support strategies provide the academic or intellectual support systems for using the primary strategies. Chief among the support strategies are metacognitive strategies, in which learners monitor their own learning and select alternative strategies if the current ones are not working. Cognitive learning strategies are diverse and powerful means for affecting how students learn.

Jonassen (1988a) has argued that cognitive learning strategies may be effectively embedded in computer-based instruction in order to raise the level of intellectual processing by learners. Other commonly used computer tools may also be used to engage students in cognitive learning strategies. Some of these tools were developed to support other activities. Some of them were developed to support cognitive learning strategies.

### The Model: Using Mindtools with Teachers

Our purpose is to 1) teach teachers how to use these tools to enhance their own thinking and comprehension of the subject matter they are responsible for teaching, and 2) to teach teachers how to teach their students how to utilize these tools to foster deeper, more meaningful thinking among public school children. We will now describe the major tools and activities that will be taught to pre-service teachers in the Teacher Education Program at the University of Colorado at Denver.

### Mindtool: Hypertext

Although the concept is over four decades old, hypertext has only recently emerged as a popular technology because of microcomputer implementations such as HyperCard. The introduction of HyperCard has resulted in the proliferation of "stackware" designed to teach and inform on practically every subject. Unfortunately, most hyperware is not hypertext, because it does not exhibit the important characteristics of hypertext, such as nodes, associative links based on explicit semantic network of ideas, dynamic control by the user, an organization structure that represents the information that it is presenting (Jonassen, 1989). The links in most hyperware are linear. The content structures are not obvious. The content is not malleable. Hypertext is potentially one of the most mind-expanding technologies available, yet few implementations of hypertext manifest that potential.

We do not believe that the most powerful application of HyperCard or any hypertext is as a delivery vehicle for instruction, an electronic textbook that instructs learners. Minds will not be expanded by having learners follow the information structure of the stackware developer. That application may be interactive, but it is not generative. HyperCard may become a Mindtool when it is used as an electronic notebook for recording and structuring what the learner knows. Just as our knowledge is dynamic and not static, because we are constantly acquiring, restructuring and tuning (to use Norman's model of learning) what we know, hypertext can mirror those processes. Hypertext will find its best application as a cognitive learning tool (Jonassen, 1989b).

### Implementation

In this project we propose to teach teachers the fundamentals of HyperCard, to let them create their own stack of information that reflect their own conceptions of the information. These stacks can be compared with other similar stacks to assess the differences in the way in which we represent information. Pre-service teachers will then be taught how to create empty stacks to let their students begin to build stacks and then how to enable public school students to create their own stack structures. Experience with HyperCard in high schools in the Denver area indicates the students readily acquire and utilize stack building skills. The result of this process will be explicit statements by students and pre-service teachers of their representations of subject matter knowledge.

### Mindtool: Expert Systems

Expert Systems are an application of artificial intelligence, where the knowledge of an expert is distilled into a set of rules that can be used to guide decision making in solving a problem. There are other more powerful expert systems (frame-based and hybrid), but they are beyond the scope of this project. Expert systems are useful tools that are used extensively in business to help users make decisions. At the University of Colorado at Denver, researchers (Grabinger, Wilson and Jonassen) have been experimenting with a variety of educational applications of expert systems. They are powerful, because they represent the expertise of the expert. For the user, however, they are reactive and not generative and therefore not mind-expanding.

Expert systems can function as mind-expanding tools. Research by Lippert (1987) has demonstrated the intellectual effects of having students create their own expert systems. The analysis of subject matter required to develop expert systems is so deep and so incisive that the learners develop a much greater comprehension of their subject matter then they were ever aware of. The development of expert systems requires analytical reasoning, metacognition, and a host of other strategies that unequivocally expand the minds of the developers.

### Implementation

In this project, we propose to teach pre-service teachers how to create expert systems to solve some procedural problems in their subject matter areas. We will use MacSmarts, which is an expert system shell. It is fairly user friendly and easy to learn. Most of the instructional effort will be devoted to conceptualizing the problem, generating examples, and creating and editing rules (see series of eight articles by Grabinger, Wilson, and Jonassen in Performance and Instruction, 1988-89 for a more detailed description of the process). Developing expert systems has a couple of major advantages for the teachers. First, it requires them to address procedural knowledge in their curriculum. The other technologies that we are focusing on produce declarative knowledge. Declarative knowledge is "knowing that," and procedural is "knowing how," to use Gilbert Ryle's distinction. Expert systems are powerful mindtools.

## Mindtool: Semantic Networking

A new class of tools, intended to foster the cognitive strategies of integration and elaboration, is known as semantic networking software. Programs such as SemNet (Fisher et al, 1988) and Learning Tools (Kozma, 1987) are powerful Mindtools that provide visual and verbal screen tools to develop cognitive maps. Cognitive maps (see Figure 1 for an example) are spatial representations of ideas and their interrelationships that are stored in memory. Research by Jonassen (1987) has shown that such maps are accurate representations of cognitive structure. These tools enable the users to identify and describe individual schemas or nodes and then to identify and classify the links and relationships between these nodes. Mapping the arrangement of ideas in memory can be instructional. It can also be used to evaluate learners' prior knowledge in a multidimensional and creative way. Research by Fisher and her colleagues at the University of California, San Diego has shown that high school students improve their learning by analyzing the arrangement of ideas in any knowledge domain.

## Implementation

In this project, we intend to use the software package SemNet, which is the most powerful genre. The University of Colorado at Denver has been designated as a beta test site for the software, which is still being developed. We will teach pre-service teachers how to analyze their own knowledge structures and to produce cognitive maps of them. These maps can then be used as instructional tools by the teachers to organize a unit of instruction. We will also teach the pre-service teachers to teach their own students how to use SemNet to analyze their knowledge structures. In addition, we will be experimenting with high school students on the cognitive effects of cognitive mapping.

## Mindtool: Database Management Systems

Database management systems are computerized record keeping systems which were designed originally to replace the paper-based information retrieval systems. The advantages of such systems over paper systems are compactness, speed of entry and access, and updating. Most database systems allow the user to create and define files, search, sort, and retrieve information from them, maintain files through editing and inserting, and printing reports. Database systems have been used primarily in business and agencies to store files of information about products, personnel, or sales.

Database management systems may also be used to foster cognitive learning strategies. Jonassen (1987b) has promoted the use of these systems to facilitate learning strategies such as cross-classification strategies or the node acquisition and integration technique. These activities analyze concepts as records, requiring the learners to describe a network of related concepts. The searching and sorting capabilities of the system enables the learners to analyze the concepts for similarities and differences. See Jonassen (1987b) for a more detailed description of the activities.

## Implementation

In this project, we intend to teach pre-service teachers how to develop their own instructional databases that reflect the organization of knowledge in their fields. We will use the database system Microsoft Works. Many high school students are already familiar with this software. Experience in the Denver area has shown that students readily acquire the skills necessary to use Works. We will also teach them how to work with high school students to develop their own as well as researching the effects of such activities on the learning of high school students.

## Implementation in Pre-Service Teacher Curriculum

These Mindtools and their applications will be taught to pre-service teachers enrolled in the Teacher Education program at the University of Colorado at Denver. All pre-service teachers in this program are required to complete the course, Instructional Technology for Teachers. The curriculum of at least half of the sections of that course for the first year will consist of the Mindtools curriculum described above.

## Research/Evaluation of Mindtools

There will be two separate research venues in this project. Evaluation of the effects of these Mindtools will occur at the university in the pre-service course and later in the public schools.

Evaluation of the effects on the pre-service teachers will occur as part of the regular instruction in the Instructional Technology for Teachers course. Evaluation will consist of the products created by the teachers (databases, expert systems, hypertext, and cognitive maps). We will also collect feedback from the students about the effectiveness and relevance of the curriculum. If the effects of the curriculum are salutary, we would expect to make permanent changes in the curriculum of that course, making it one of the most advanced and creative pre-service instructional technology courses in the country.

In addition to evaluating the products of the pre-service teachers in the course, we have also developed a research agenda for evaluating the effects of these tools on school students. Specifically, we are examining the effects of these tools on structural knowledge (the awareness of the interrelatedness of ideas in memory), recall, and retrieval of subject matter knowledge. We will also examine the effects of these activities on more traditional curriculum-based evaluation instruments. This research will be conducted in four different high schools in the metropolitan Denver area, each of which have

Macintosh laboratories and teachers who are willing to cooperate in the conduct of this research. This bi-level (university and public school) approach to evaluation is unique in such a project. It is important to evaluate just how mind expanding these Mindtools can be. Such research must be conducted in the public schools in order to have ecological validity. That is, the effects have to be measured in a normal instructional environment rather than in a clinical setting.

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# TIPS:

## AN EXPERT SYSTEM WITH THE USER IN MIND

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### ABSTRACT

The Instructional Prescriptions System (TIPS) is the first member of the Ford Aerospace HUMORS family of on-line curriculum-development tools. It provides domain-independent, delivery medium-independent tips on teaching strategies. TIPS guides users to define: a body of knowledge, the student population, and the errors new job incumbents commonly make in the workplace.

### TIPS:
### AN EXPERT SYSTEM WITH THE USER IN MIND

The Instructional Prescriptions System (TIPS) is an expert system for instructional design. It advises about the strategies that should be used when planning or designing instruction. These strategies address cognitive subject matter, not the psychomotor or affective domains. TIPS will not help to teach the fundamentals of the kick stroke or the parameters of aesthetic intuition. These limitations are not considered to be serious shortfalls, however, because TIPS focuses on the needs of technical training.

Contemporary approaches to technical training typically emphasize cognitive instructional goals, with the behavioral orientation taking a lesser but still important role. Attitudinal goals for instruction usually are not addressed directly in technical training.

TIPS is different from many other systems in that it requires no special background or preparation. It is intended to be used by people who are subject matter experts in a technical discipline--other than instruction.

Most technical training is developed or conducted by SMEs (subject matter experts). This is so for two reasons: the most important attribute of any effective instruction is factual accuracy, and this requirement is protected best by employing SMEs; the other reason is that there are not enough well-trained, qualified instructional designers to staff all of the existing projects for instructional product development.

Given that most training is either developed or delivered by SMEs, it becomes apparent that this is the population that needs whatever guidance and assistance can be offered. To make the assistance meaningful and accessible, TIPS avoids all jargon, all buzz words, all andragogically sensitive phraseology.

### BACKGROUND OF THE PROBLEM

The origin of the system was an R&D sponsor's request for an automated job aid that would help in decisions about whether or not CBT was a good choice for a given instructional problem. After some study and reflection, we suggested that this type of problem already had been treated by Greg Kearsley's CBT Analyst. Furthermore, we proposed, the most typical determinations about whether or not to embrace CBT are founded on considerations having almost nothing to do with instructional theory, and almost everything to do with highly individual implementation constraints. What made more sense for us was to imagine building an expert system that would make it easier for practitioners to draw out the benefits of learning theory where they are available. Even if learning theory often is not used, we proposed that it should be used. To promote its use, we agreed to work on a system that would make more useable the already useful tenets of learning theory.

## STRUCTURE OF THE KNOWLEDGE BASE

TIPS' knowledge base is created as a matrix of: all possible instructional goals; all possible instructional problems; all possible student types. Into the cells defined by combining these categories of learning variables, we have entered all possible instructional strategies. The provision of this knowledge is one of the ways TIPS is intelligent.

### Goals

Having dedicated TIPS to the cognitive domain, all of the possible goals necessarily had to be aspects or forms of cognition. The strongest, most generalizable base for this leg of the matrix is Robert M. Gagné's five major Categories of Learned Capabilities. Some modifications were made to Gagné's system right at the outset since it already had been determined that Motor Skills and Attitudes were not going to be treated. The Verbal Information capability also was changed, being subdivided along new lines of our own design. This was done to accomodate our attraction to the cognitive, constructivist orientation that has quite a long, if intermittent, tradition.

One thought that drove much of the thinking for this part of the matrix was how easily misled we human observers can be when it comes to assessing the components and significance of physical performance. This is certainly not original on our part, but it remains compelling. The example of two volunteers at the site of an automobile accident came to mind frequently. If one volunteer was a certified emergency medical technician and the other volunteer was an emergency-room physician, it is likely that their physical responses to patients' needs would appear indistinguishable, while their performances would be distinct in dramatically important, cognitive ways. This type of distinction has presented itself again and again in our own teaching careers, as it has, if somewhat spottily, in the literature. We have taught many students who were fluent with their words or productions, at least in the most concrete of senses, while being completely out of touch with the expert's appreciation of the "essence" of the discipline, whatever it may happen to be. This is just too big, and too prevalent an issue to disregard.

Just as our ideas were beginning to come together on this point, we learned that Prof. Gagné and Prof. David Merrill also were interested in this sort of problem. They explained to us that they were hoping to consider "integrative" goals that would carry instructional design past some of the perceived limitations of Gagné's original set. Ford Aerospace arranged a four-way collaboration during the Spring of 1988 to pursue just such an extension. A final formulation of those discussions has not yet been established, and perhaps one never will be. We hope and believe, nevertheless, that our hierarchy of cognitive primitives, which takes some liberties with Gagné's original Intellectual Skills and Cognitive Strategies, can synthesize much of the best parts of that work.

### Problems

Beyond types of knowledge, we reasoned, an expert system advising on instructional design should consider what types of problems learners have in mastering the content. Our dedication to SMEs made this a difficult task at first. Another value eventually took the problem away altogether in an unanticipated fashion.

An early field test of the system with an SME in our Department showed the difficulty of asking about learning problems. Our first prototype asked the user to answer critical, specialized questions about the types of difficulties learners encounter. A series of "Why" and "Help" facilities were accessible from each screen to provide additional support in answering the questions. It was our plan that we would ask why neophytes have difficulty grasping the interrelationships of a discipline. This question would stump the SME, momentarily, with the accessory "Why" and "Help" facilities being used to resolve the confusion.

Our friend consulted none of these facilities. He read the questions, thought for a bit to try to figure out what we had really meant, and then answered the question we "should" have asked in the first place. We had not expected him to disregard the specialized significance of some of our careful, even scientific terms. Yet, what we had not expected probably was inevitable.

What we had not accounted for was the inescapable fact that absolutely everyone is proud of their individual abilities to learn. Absolutely everyone has a background of learning experience to draw on, just waiting for someone to ask. That is to say, all of us consider ourselves to be some sort of learning theorist. Whether others are more or less conversant with the literature is a minor pettiness. Everyone is certain that "knowing about knowing" is something they know about.

Asking carefully phrased questions about learning problems seemed less of a good idea, all of a sudden.

The solution we chose to this dilemma seems painfully obvious from an historical perspective: if the internal conditions of learning are unreliably or too-peculiarly described, infer their nature by the more dependable descriptions of the external conditions of learning.

SMEs are trusted judges of what preposterous mistakes new people make on the job. Often they even have ready supplies of practiced stories that capture entertainingly the very crux of the error. It is inappropriate, however, to expect that they could report the cognitive significance of these events, using concepts and terms from a discipline other than their own. The translation task should not be too great for trained interviewers, though. They should be able to extract the salient parts from the anecdotes, and then the expert system could connect these salient parts for treatment by the principles of learning. So, the retrospectively obvious choice was selected. The external events would be requested and the internal events would be inferred.

To accomplish this, we first wrote the questions we wanted to answer. These were correct, but unsuitable because of their reliance on the technical vocabulary of learning theory and instructional design. These questions then were re-phrased, using common, everyday language, to make them useable by SMEs from outside education/training. Next they were revised yet again. This time the dominant consideration was the tight expression of the idea for display on a computer screen. Too many words on a screen is unpleasant, and ineffective. By the time the final transformation had taken place, the verbal expressions were general enough that they could apply equally to overt, physical or invisible, mental performance.

## Students

For our purposes, there are only three types of students. In a certain sense, there are as many different types as there are different students. Students are unique, sort of. That is to say their differences are categorical; they differ from one another in the same ways as one another, with learning style, developmental stage, personality orientation, skill levels, background knowledge, and the like. Furthermore, most of students' differences are realized in ways that are not susceptible to treatment by the canon of instructional design.

Mood, health, motivation, personality integration, purposiveness, embarrassed self-consciousness about new glasses, intimidation about the threats the class bully has promised to make good on at recess, and a crush on the new teacher are the truly strong correlates with learning, and these are not greatly or directly influenced by how we sequence the events of instruction. The special problem of instructional design is building programs that fit in with, and work in spite of, all of the social phenomena that command attention more immediately than what is written on the lesson plan.

TIPS distinguishes only between: neophytes, who lack the information of the discipline, and also its background; SMEs in a similar or related discipline; experienced learners who are ignorant of the particulars of the background but who understand a great deal about other realms of knowledge--including, significantly, their best ways of learning new things.

## Strategies

Fourteen instructional strategies are used in TIPS. As with the different types of students, these are categorical. In actual performance, it could look like there are many, many more, because different people manifest the strategies in such creatively different ways. When looking for the differences that matter most across all strategies, it seems there are about fourteen.

Nowhere in the strategies consideration is there any thought given to media. This is because any different medium can employ almost any different strategy, depending on the ID's fluency in the symbol system of the medium, and on local implementation factors. The strategies are derived from principles of learning; media are not.

## OPERATING THE SYSTEM

A booklet introduces the first-time user to the system, and to the ideas it seeks to influence. Some possible users may not feel comfortable with computers, so a booklet is provided to extend the first connection. Some users may have no idea about instructional strategies, what they are, and why anyone would care about them. An introduction to these topics is offered, or it can be skipped easily by those who have no need or interest in these sections.

The first interaction on-line requires the user to name the subject under consideration; he is asked to type it onto a screen. There are no guides or prompts about this request, except for the booklet that explains that any body of knowledge can be treated by TIPS. On hitting the RETURN key, a new screen appears that asks for the user to name the important topics in the subject.

This is a difficult, and somewhat controversial, point in the program. Even SMEs find it difficult to break their subject area into chunks. Still, SMEs are the best-qualified people to do this. If the goal of the intended instructional program is to create more people exactly like the SME, then there may be no alternative to this challenging beginning.

One interesting possiblity for alleviating some of this problem is to ask teams of SMEs to work together. It is likely that the SMEs will have different opinions of how to break up a subject area or how to answer some of TIPS' direct, forced-choice, selected-response questions. The conversations that resolve such differences are expected to prove fruitful in clarifying one's own point of view. This is another, unique way that TIPS is an intelligent system. It synthesizes intelligence from the contents of its own knowledge base and the unique, integrated particulars of the SME user's background.

There has been some thought given to having the system provide guidance for this task of dividing the content. That may eventually prove to be necessary. It is not yet possible to say whether or not that will become a requirement, at least not with any certainty. At this point, no field trials have allowed systematic and rigorous evaluation of the system. We cannot say where its inevitable shortfalls will materialize. One way of responding to this potential problem, however, is by minimizing the negative consequences of wrong choices. TIPS does this is a few ways. Firstly, there is no judgement in the system. Whatever the SME enters is accepted. Secondly, TIPS is designed to provide quick responses. A consultation with the system often can be completed in less than five minutes. With such quick turnaround, the SME has not invested a great deal of time. It is easy to go through the system a second time, answering the questions slightly differently. In all ways possible, TIPS lets the user be in charge of the system's operation.

The second screen presented is determined by the answer selected on the first, of course. This starts the user down one of the more than 7,000 branches that are available in the system. With so many branches, it is important to make sure that the user does not get lost. As with any diagnostic program, there is a danger that the user will answer a question that is somehow different than the one intended. That is to say, he might misunderstand a fine point of what was meant, calling for him to give an answer different than he might have intended. Even one misunderstood word or specially chosen technical term can frustrate the proper conclusion--for that particular user.

To protect against that eventuality, TIPS asks each question at least twice. This paraphrase capability is intended to ensure that the user and the system are "speaking each other's language."

Even if the system's questions and the person's answers are fully understood, there still may be a problem formulating an appropriate prescription. It is possible that the knowledge base does not anticipate quite all of the possible categories of cognition or performance problem. Some system users could arrive at TIPS with a problem that is outside the realm of the advice. Such cases are detected as early as possible using the paraphrase, and a warning message, or "failsoft," is presented. This cautions that the final advice may not be as strong as we would like. The user is then offered the choices of: proceeding to find out what happens anyway; ending the consultation; returning to an earlier point in the program to change some answers; or going back to examine and debate earlier questions with a friend. Again, the emphasis is on providing choices, and teaching their reasons and consequences with the Why's and Help's, so the people can use the tool to fit their own needs best.

The final output of the system comes in sentence form, using common synonyms for the technical labels of the instructional strategies. Three or four different strategies are proposed, in a set sequence, for the user to interpret and implement individually.

While each prescription is media-independent, appendices in the booklet provide hints on how to use the different strategies in a variety of media.

## ACTING ON A TIP

It is possible for the system to fail. There is no pretense that TIPS will completely protect anyone from bad judgement. The human user can enter bad or capricious data. The system can be overcome. Likewise, TIPS will not guarantee a virtuoso performance. It will not ensure that all students pass. It will not make the user more skilled than he or she is capable of being. It systematically leads the user down a stable, replicable, verifiable path to an appropriate instructional prescription that can be instantiated using skills already existing in the user's repertoire, but that is all.

One of the more unusual characteristics of the TIPS system comes out of just this dedication to the users' free choice. Of the four strategies recommended, one might seem very wrong. In that case, the user is advised to disregard it. Maybe it is wrong. Perhaps it is an artifact of how the questions were phrased instead of what was meant. It could be that the problem domain in the user's mind has some special characteristics not anticipated in the system's knowledge base. If it does not feel right, the advice is meant to be ignored.

Similarly, the prescriptions are categorical, and general, rather than explicit and directive. Each must be interpreted before it can be acted on. This feature derives from the belief that people will do best what they know how to do.

Even when an instructional problem begs for a role-play simulation, if the person feels uncomfortable with it, it is the wrong answer; it will be implemented poorly and it will go wrong if it is acted on uncomfortably. This sounds unscientific, but it is realistic.

After a consultation, the person makes a selection and uses it for planning the development or delivery of instruction, or uses it for making a media decision, or uses it for facilitating a discussion between an SME and an ID, or uses it or not in a unit development folder as an historical record of the curriculum-development decisions made on that day. There really is meant to be quite a lot of freedom in using the tool.

## EVALUATION PLAN

The final evaluation of The Instructional Prescriptions System will reflect the locale of its implementation site. Some intriguing possibilities may not be feasible in every different setting. Some basics remain stable, however.

The first component will be the verification of the prescriptions themselves. This will be done by expert reviews and expert matching. An instructional designer or technologist of recognized standing will be asked for recommendations about the same set of content type, student type, problem type situations. Reviews of the entries in the knowledge base and assessment of the concordance will be one measure of quality.

Next TIPS will be used in a schoolhouse setting to address a real training problem. This may be undertaken by SMEs, or by junior instructional designers, or by both types of people working together. A number of different approaches have been imagined. This evaluation will determine how TIPS serves the user population.

The final evaluation exercise will be the implementation of the instructional prescriptions for the development of actual curriculum materials. This will determine whether the recommendations can be implemented, and whether they can be used to create effective materials.

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# BILINGUAL POSSIBILITIES ON THE MACINTOSH:

# AN APPLICATION TO LANGUAGE LEARNING

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## ABSTRACT

The development of bilingual teaching materials has always been hindered by the lack of easy-to-use and cheap software that can represent different scripts as well as handle sound. With the emergence of new Macintosh software, language teachers can now attempt writing such materials themselves. The example proposed is for Chinese and English, but possibilities for other language combinations also exist.

## INTRODUCTION

All of us grow up speaking at least one language, our native language or mother tongue. Many of us also learn a second language in addition to our mother tongue. Language teaching experts do not agree on the usefulness of the mother tongue as a medium of instruction for the second language. Some researchers believe that the best way to teach a new language is to immerse the learner completely in the language he is trying to learn. Others hold the view that if the learner already knows his mother tongue well, then he can learn faster and more confidently if some of the instructions in the beginning classes of the new language are given in his mother tongue. Such disagreements aside, there will be circumstances where the use of the mother tongue in juxtaposition with the new language will be inevitable, for example, in the preparation of bilingual dictionaries or glossaries. Thus, for the computer to play a greater role in the area of Computer Assisted Language Learning (CALL), possibilities of bilingual computing should be explored.

The present lack of bilingual CALL materials is directly related to the lack of software for bilingual computing. While software for the development of monolingual materials is plentiful, there is hardly any for the preparation of bilingual materials. Even if it exists, it tends to be only for wordprocessing. (See for example Kemp, 1986). Effective CALL materials require software that allows for more interaction between the teacher through the computer lesson and the learner as user of the computer lesson. Interactive procedures such as tracking responses and providing feedback are the basic essentials. Bilingual wordprocessors do not provide for such interaction. Besides, true bilingual computing involves not just the representation of the writing scripts but also the capability to input and output sound. Although developments in speech synthesis have been rapid in the last decade, the hardware and software needed for such research are not only too expensive for the average school budget but also too difficult for the ordinary language teacher to use. And yet, the best CALL materials must necessarily involve the teacher for it is the teacher who, in his/her day-to-day teaching, can best gauge what the class needs at any specific point in time.

To recapitulate, the system needed for the preparation of bilingual CALL materials must:

i) be able to represent two writing scripts
ii) provide for interactive procedures
iii) be able to input and output sound
iv) be easy to use
v) be cheap

# Bilingual possibilities on the Macintosh

This paper aims to show why the Macintosh is suitable for preparing bilingual CALL materials and how simple materials of this nature can be created. The example used is for Chinese and English. First, the procedures to input two scripts and sound are described. Then, some specific examples of CALL materials to teach different language skills will be outlined.

## THE SUITABILITY OF THE MACINTOSH

The Macintosh is found to meet all the five criteria listed above. To begin with, because the Macintosh is graphics based, it can handle two scripts at the same time with felicity. When operating in the English operating system, Chinese text can be imported as graphics. If the Chinese operating system (Chinesetalk) is on, English text can be imported as graphics. Either way, it is possible to have both scripts on the same screen simultaneously. Secondly, HyperCard which was released by Apple in August 1987 as an authoring tool allows for basic interactive procedures such as timing of students' responses and recording their answers for later evaluation by teachers as well as feedback and rapid branching to sub-modules to cater to individual needs. An added bonus to HyperCard is that it can import sound using a companion tool, the MacRecorder and the attached software, HyperSound and SoundEdit, which were released by Farallon in 1988. As for ease of use, the Macintosh has always been rated highly on this score. Even a child can use it without tedious training. All Macintosh software comes in the standard format of pull-down menus, windows and scroll bars so that if one knows one Macintosh software, it is easy to pick up another. However, such ease for the user is directly proportional to the difficulty in developing software for it. Fortunately for the language teacher, the introduction of HyperCard has changed this state of affairs. With HyperCard, even non-computer experts can author programmes, called HyperCard stacks. Finally, in terms of cost, HyperCard is bundled with the purchase of a Macintosh. HyperSound and SoundEdit also come free with the purchase of the MacRecorder which costs only around US$220. The other software, ChineseTalk and MacPaint, which may be needed for inputting Chinese text are around US$75 and US$150 respectively. Prices quoted are after educational discounts.

## BISCRIPTUAL DISPLAY

In this section, the procedures for biscriptural display are described. The eventual mode of operation is assumed to be the English operating system. English text is input in the normal way. And Chinese text can be input using one of the following methods which vary in whether software besides HyperCard is needed. The other software that may be required are: ChineseTalk (Chong Wen Talk) and MacPaint.

The three methods described below are:
Method 1 - Using ChineseTalk, MacPaint and HyperCard
Method 2 - Using ChineseTalk and HyperCard
Method 3 - Using only HyperCard
(See Lam, 1989, for a full discussion of system requirements and the use of a scanner as a supplementary input device.)

### Method 1 - Using ChineseTalk, MacPaint and HyperCard

This requires one Megabyte of Random Access Memory (RAM).

i) Start the computer on ChineseTalk.
ii) Open a new file in MacPaint and enter Chinese text. Save it.
iii) Quit MacPaint and ChineseTalk.
iv) Restart the computer on the English operating system.
v) Open the MacPaint file you created in Step ii). Select the Chinese text you want and copy it onto the Clipboard. Quit MacPaint.
vi) Open your file, called a stack, in HyperCard where English text has previously been entered. Move the insertion point to where you want the Chinese text that you copied in Step v) to be inserted. Select **Paste** on the **Edit** menu to unload the Chinese text from the Clipboard onto your HyperCard stack.

### Method 2 - Using ChineseTalk and HyperCard

This requires two Megabytes of RAM. The procedures are the same as in Method 1, except that Chinese text is created using HyperCard instead of MacPaint.

### Method 3 - Using only HyperCard

This requires one Megabyte of RAM and no additional software. But the Chinese characters are only as elegant as your handwriting is.

i) Start the computer on the English operating system.
ii) Open a new stack in HyperCard and type in the English text.
iii) Use the pencil (for small characters) or paintbrush (for large characters) on the HyperCard toolbox to write in the Chinese characters.
iv) Select these Chinese characters and adjust them to an appropriate size.
v) If necessary, use the FatBits mode to smoothen out the ragged edges of the characters.

Of the three methods described, Method 1 and Method 2 are especially suitable for small characters and Method 3 for large characters.

## INPUTTING SOUND

The Macintosh is equipped with a sound port. To input sound, just plug in the MacRecorder which is a sound digitizer. It comes with two software options for recording sound. They are HyperSound and SoundEdit. (See Lam, 1989, for system requirements.)

HyperSound is a HyperCard stack. To use it, just click on its icon and a screen resembling a tape recorder will appear. To input sound, press the **Record** button. There are also buttons for **Play**, **Reverse**, **Forward**, **Stop**, **Erase** and **Quit**. They correspond entirely to the operating functions of an ordinary tape recorder; **Quit** will get you out of HyperSound. When recording, you can adjust the amplitude of your input as well as output. The sampling rate can also be varied. If you want a sound that is very like the natural sound you record, you choose a high sampling rate. If you are satisfied with a more artificial sound, you can choose a lower sampling rate. At the lowest sampling rate, you can record up to 3 minutes per Megabyte of RAM or disk (Farallon Computing, 1988, 2-13). Sounds recorded in this way can then be transferred onto a HyperCard stack and can then be played by clicking on what is called a 'button' in the stack. To play back sound, you do not need to have the MacRecorder attached to the Macintosh.

SoundEdit, the other recording option, allows you to edit sound, for example, take out the middle portion of a string of sounds. To use it, just click on its icon. A window will appear and at the bottom of this are icons that you can click. The icon for recording is a microphone and that for playing back is like a loudspeaker. With SoundEdit, it is also possible to add sound effects to your basic sound, for example, echo effects or playing a string of sounds backwards.

Whether you use HyperCard or SoundEdit to input the sounds you need, the playing back of the sounds is just as easy. Sounds created either way can be put into a HyperCard stack and played from there by the clicking of a 'button'.

## BILINGUAL CALL EXAMPLES

The system described above can be used at various stages of language learning for the development of different language skills.

For teaching pronunciation and listening, some possibilities are:

i) Use a mouth diagram to indicate the position of articulation of various sounds in English and Chinese and have these sounds recorded so that each can be played back with a click on the symbol for the sound. HyperCard allows for a certain degree of animation so that the articulatory organs can be shown to move in a certain direction with the production of the sound.

ii) Students can also be taught to use HyperSound to record their individual attempts at pronunciation practice so that the teacher can check them later. This is easier than checking on a tape recorder because the records of the students' oral practice can be checked and compared without rewinding or fast forwarding a tape to find their samples.

iii) Text, for example, a conversation, can be displayed in its bilingual script and the verbal exchange can be played back in the language being learned.

iv) At a higher level, SoundEdit is especially useful for showing graphically the differences between different speech sounds, for example, an aspirated [p] and an unaspirated [p] or how combining [t] and [s] can give a new sound [ts]. The teacher can show these sounds graphically and literally cut away or combine different parts of the sounds and then play the edited sounds to the students to show the effects. Another possibility is to use these graphic diagrams of the sounds to show the effects of tonal differences.

For teaching reading and writing,

some simple but useful exercises can be:

i) Bilingual flashcards or word puzzles to improve vocabulary can be easily created.

ii) For added interest, the items in the drawing of a room, for example, can be labelled in English and Chinese and the pronunciation of these words can be given by clicking on the labels. HyperCard is especially suited for providing this type of pictorial context as it comes with full graphic tools, including readymade artwork for importing into your HyperCard stack, if you are not a very good artist. With a scanner, the possibilities are limitless.

iii) Vocabulary in reading passages can also be glossed in the native language of the learner and the gloss of the difficult word can be made visible by clicking it.

iv) Even more ambitious will be the building of an on-line bilingual dictionary (Lam, 1989) which can save the learner a lot of time if he/she comes across difficult words in his reading or if he thinks of using a particular word in his essay writing. HyperCard is especially useful for such searches as it can do them non-sequentially.

## CONCLUSION

To conclude, though at present, there is little bilingual CALL software, especially that involving alphabetic and non-alphabetic scripts, the availability of the Macintosh system and the affiliated software offers many possibilities which are only sketchily discussed in this paper. Although the system reviewed is limited in that it is only digitized speech and not synthesized speech, which means that the computer does not really understand what it plays back, nonetheless, in the hands of a resourceful teacher, it can still be very effective. The main advantage is its simplicity and low cost which makes it possible for the average language teacher to use. Finally, although the illustrations are on English and Chinese, it is very possible that a similar approach can be used for other language combinations since the Macintosh can be operated in other languages. For many of these languages, it may even be easier to create bilingual materials as they share the Roman alphabet with English and the one or two other letter symbols that are needed are already available from the keyboard as alternate options.

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# AN EXPLORATION AND ANALYSIS OF THE RELATIONSHIPS AMONG OBJECT ORIENTED PROGRAMMING, HYPERMEDIA, AND HYPERTALK

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## ABSTRACT

This paper presents an overview of the fundamental concepts of both object oriented programming systems and hypermedia. Hypermedia and object oriented programming systems (OOPs) represent examples of "open" computer environments which allow the user some access to parts of the code or operating system. Both systems share many fundamental intellectual constructs, so that an understanding of hypermedia can help in the understanding of OOPs and vice versa.

The fundamental concepts of OOPs (objects, messages, methods, classes, and inheritance) each have some counterparts in hypermedia systems. The degree to which the counterparts are intellectually and operationally parallel, however, differs markedly for particular hypermedia applications. In HyperTalk (the programming environment for HyperCard applications on Apple Macintosh), for example, cards and buttons are analogous in some ways to objects, and handlers and scripts are somewhat analogous to messages. HyperTalk, however, does not support inheritance. This paper explores and analyzes these and other relationships and shows how an understanding of OOPs can help in understanding hypermedia and in developing hypermedia applications.

## INTRODUCTION

In 1945, Vannevar Bush described his vision of the future of information retrieval systems. This dream, called Memex, provided access to online text and graphic information, the ability to enter notes and other information by the user, and the ability to link any two items together. Although Memex was never actually developed, it provided the conceptual basis for more sophisticated interactive information retrieval systems, such as hypermedia and object-oriented programming systems.

Large software systems are often complicated and easily disturbed by outside influences. Some systems choose a "closed" approach to change by not allowing the user entry to either the code or the operating system. (Examples are commercial spreadsheets like Lotus 123; and word processors like WordStar.). Other programs are developed using an "open" policy in which the user has access to the code, the operating system, or both. Hypertext and object-oriented programming systems are two such "open" environments currently under development for information retrieval applications.

Hypermedia, also referred to as interactive multimedia, holds great potential for education and training. Object-oriented programming offers a powerful conceptual tool for analyzing and solving computer-based problems, particularly problems utilizing advanced technology applications. This paper will present an overview of the fundamental concepts of both object-oriented programming systems and hypermedia and a comparison of the two systems.

## OBJECT-ORIENTED PROGRAMMING

Object-oriented programming (OOP) languages have been used to develop database

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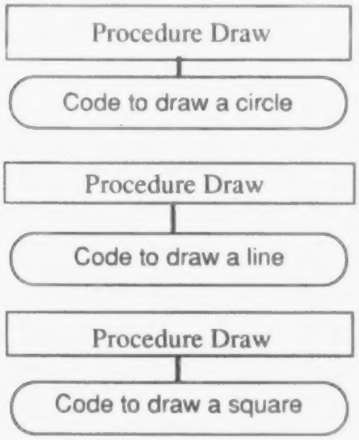
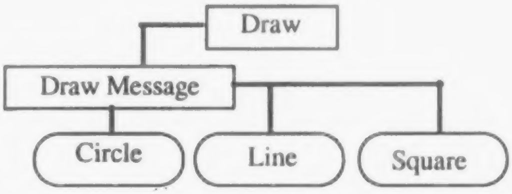
systems, authoring systems, and expert systems. Some examples of OOP languages used are Smalltalk, C++, and Objective C. Although these languages may store information differently, the way they treat objects at the programming level is similar. The five primary concepts which distinguish object-oriented programming systems from other traditional systems are objects, methods, messages, classes, and inheritance.

## Objects, Methods and Messages

Wegner defines an object as anything which has "a set of operations and a local shared state that remembers the effect of operations". They are the portions of a program that send and receive messages. (Wegner, 1989) Methods are the procedures or functions that are needed to control the object when it receives a message. A message corresponds to a function call in a traditional procedural language. In traditional programming systems, data and procedures are separate from each other. An object-oriented programming system combines the object and the procedures or methods needed to control the object. This system feature is called encapsulation. (Thomas, 1989). For example, in traditional programing, in order to draw a circle, square, or line, the program would have to contain separate procedures to draw each of those "objects":



An object-oriented program, on the other hand, would be organized in this manner:



The user tells the object what needs to be done and the object chooses the appropriate method from a table of operations the object knows how to do. In other words, instead of programs being organized into procedures that control global data, the data are bundled with the methods needed to access the data. Methods belonging to the object or data can only be triggered by sending the object a message.

## Classes and Inheritance

The other major features specific to object-oriented programming systems are class and inheritance. A Class is a group of objects with common operations or consistent behavior (Shafer, 1988). Inheritance carries out code sharing by having the language rather than the programmer reuse code from one class to another related class. Inheritance, then, can be used as a vehicle for creating objects that share attributes with similar objects. (Thomas, 1989).

Wegner states that inheritance allows objects and their methods to begin not as new pieces of code; but as a single statement which refers to another class already defined within the program, and describes how the new object or class is different from the existing one (Wegner, 1989). This ability to inherit behavior results in what Shafer describes as " an ever-expanding and descending chain of heredity" (Shafer, 1988). Information is transmitted to all the places where it is needed. The end result would look something like the following example and would provide the ability to reuse program modules to both the system and the user:

Class: Transportation
  Class: Motor Vehicle
    Class: Sedan
      Instance: Full-size
      Instance: Mid-size
      Instance: Compact
    Class: Van
      Instance: Full
      Instance: Mini.

If the class Transportation has a method called "StartIt', every member of each subclass can use that method. If the message "StartIt" is sent to the object "mini", that object does not need to have a method called "StartIt". The system just passes the messages up the hierarchy until a corresponding method is found. All these features -- the encapsulation of objects and methods together, the use of messages to send and receive information, the creation of classes, and inheritance -- create an environment for a different and exciting style of programming.

## Hypermedia and HyperTalk

The term hypertext was coined by Ted Nelson in the 1960's while working on a computer system called Xanadu. The Xanadu system was designed to use links to organize separate data banks of online information (Nelson, 1967). Hypertext, as defined by Nelson, denotes non-sequential reading and writing (Smith, 1988). Hypertext systems allow programmers and/or users to link information together. These links connect material in one document to related information in another. Hypermedia is used to describe a hypertext system which includes textual information plus additional information in other forms, such as different types of graphics, video, music and other sounds, and speech. With hypermedia, both the programmer and the user can create links to any or all of the information stored in the different formats (Por, 1987).

In hypertext systems information must be put into some sort of logical structure so it can be stored, found, and retrieved. Hypermedia systems parse information into small distinct modules, called nodes. Each node is made up of one concept or idea. The information included in a node is displayed on one computer screen at a time, as in Apple's HyperCard; or in groups of nodes, as in Xerox Palo Alto Research Center's (PARC) NoteCard system. (Fiderio, 1988). Links are used to connect the nodes by networking related text or information in other formats. A hypertext link is an electronic pointer that directs the user to associated information. Links are hypertext's transportation infrastructure; they are the routes the user follows to move from one node to another.

According to Fiderio, links have two basic characteristics: they must be traceable by the computer, and they must be able to route the user from one node to another as rapidly as possible. Links normally originate at a single point, which can be a single text character, a string, or an icon. These points identify links in a document. Guide, the hypertext package developed by OWL International for MS-DOS and Macintosh computers; and Apple's HyperCard for the Macintosh both refer to these points as buttons (Fiderio, 1988).

## Comparison of OOPs and HyperTalk

There are some strong parallels between OOPs and HyperTalk. The fundamental concepts of OOPs (objects, messages, methods, classes, and inheritance) each have some counterparts in hypermedia systems. The degree to which the counterparts are intellectually and operationally parallel, however, differs markedly for particular hypermedia applications. In HyperTalk (the programming environment for HyperCard applications on Apple Macintosh), for example, cards, stacks, and buttons are analogous in some ways to objects; handlers and scripts are somewhat analogous to methods, and links are analogous to messages. HyperTalk, however, does not support inheritance.

## Advantages

Both Hypermedia and OOPs have virtually unprotected, changeable, operating systems. The source code which specifies the configuration of the entire system is immediately available to any programmer, and that programmer's entire programming environment can be immediately changed in almost any manner just by changing a few lines of code. Both types of systems are designed to emulate the way humans store and retrieve data. They therefore alleviate the frustration of retrieving data by allowing a more natural, nonlinear method of searching for information. They allow programming languages to be unusually small. The complex syntax needed to declare data types is unnecessary because everything is of only one type, an object. Its contribution is restricting the effects of change by placing a wall of code around each piece of data (object). All access to the data is handled by procedures that were put there to mediate access to the data, and allows for the reusability of code as well as easy maintenance or modification of code.

OOPs promises much more than a point-and-click window interface. Carefully designed class libraries let you quickly assemble applications from prefabricated parts. The power of even limited systems, like HyperCard and Lotus Macros, shows how quickly end users can build their own integrated applications, given the appropriate framework.

## Disadvantages

The issue of standardization within object-oriented programming languages needs to be addressed. Establishing standards both in the source code and the terminology used would allow much more flexibility and portability of the source code from one context to another.

Hypertext is still in the developmental stages with a number of major problems still to be resolved. Even with extensive search capabilities, it's still not always possible to retrieve the desired information or avoid getting lost in the maze of hypertext links. There is also the difficulty of breaking a thought or a segment of information into a single node. Hypertext systems also have problems in helping the user visualize how the information is linked together; answering such questions as "What information is available?" and "How can I get to it?"

A major problem with hypertext, according to Fiderio, is that hypertext systems give the user control when the user actually needs guidance. With the user's ability to make his or her own links, comes the risk of making the wrong choice and getting lost in the maze of link paths created in the process.

## The Future of OOPs and Hypertext

There is a great interest in the development of interactive learning systems. In their analysis of object-oriented programming, Dodani, et.al state that interactive software provides an important incentive to execute the user interface as an independent component. This separation, they claim, has several advantages. First, the user interface can be subdivided into components that can be joined in different combinations for specific purposes. Second, the interface can be modified quickly for use in other applications. Third, the interface can be changed or even removed without any harmful effects on the rest of the program. Finally, the interface can be developed on an ongoing basis, with prototypes continually being tested until the "perfect" design is developed (Dodani, Hughes, and Moshell, 1989).

In order to provide the type of separate system described above, we first have to change the organization of information into groups of concepts rather than isolated facts. We need to take advantage of the relationships between concepts; begin to consider what the learner understands; and to anticipate the learner's next choice, or to suggest a different direction (Weyer, 1988).

OOPs and hypermedia appear to be the likely tools not only for development of full programs; but also for the development of the interactive user interfaces to other, already developed programs. They are both systems which force the programmer to look at knowledge from the learner's perspective and needs. They provide the tools necessary for "navigating" through the maze of information resources available to the user. These systems hold the promise of allowing us to look at information the way we organize our own thoughts, and to make nonlinear connections between different bits of information.

Hypermedia and object-oriented programming systems are two very powerful tools, still in their developmental infancy. It will be exciting to see what the next five years bring in the world of information search and retrieval systems.

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# THE LIMITATIONS OF HYPERMEDIA FOR INSTRUCTION

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## ABSTRACT

Recently there has been a significant increase in interest in a new form of computer based information management called hypermedia. Actually the concept of hypertext has been around for more than 40 years, but recent advances in computer technology have provided the opportunity to experiment with many new features or concepts, thus promoting the recent upsurge in interest.

Hypermedia systems are designed to provide a means of allowing an individual to store or retrieve large amounts of information in structures which traditional media including computers do not allow. The concept is based on a view of human memory that says that humans store information through associations rather than linear straight line structures, typical of written media like books and traditional computer databases.

Some of the current and varied uses of hypermedia systems include programing, authoring, project management, legal research and engineering design (Conklin 1987, Fiderio 1988). Additionally hypermedia has been mentioned as a means of delivering computer assisted instruction (CAI) (Conklin 1987, Fiderio 1988), but little has been written concerning what is needed to make such systems suitable for instruction. It is the intent of this paper to describe the potential advantages of hypermedia systems as an instructional environment, the additional features which must be added to such systems for the purpose of delivering effective instruction, and some of the educational research issues associated with hypermedia.

## FEATURES OF HYPERMEDIA SYSTEMS

Hypermedia has been referred to as everything from an approach to information management (Smith and Weiss, 1988) to a DBMS system or a software environment for collaborative work (Fiderio, 1988, Trigg, Suchman & Halasz, 1986). Regardless of what they are called, there are key features which make up any hypermedia system.

Hypermedia systems, which are really a logical extension of hypertext systems, are designed to provide a means of allowing an individual to store, retrieve, and navigate through large amounts of disparate information in ways which simply defeat traditional media. Hypermedia systems include information in forms including text, graphic, film, and sound and allow the information to be structured in at least three-dimensional associations. Hypertext systems have emphasized only textual related pieces of information but the concept of storing and retrieving the information in structures other than straight linear fashion still applies. The critical underlying premise is that human memory stores information through associations rather than straight-line means, typical of written media like books or standard databases. By providing a medium capable of storing not only individual pieces of data but data in many forms and being able to store the linkages or associations between the various pieces of information the computer system is more closely reflecting human memory storage and retrieval.

Hypermedia systems store and retrieve data or information in discrete units. These units may be called nodes (Halasz, 1988 Fiderio, 1988), frames (Akscyn, McCracken and Yoder, 1988) or cards (Halasz, Moran and Trigg, 1987) but they manifest the critical feature of being discrete elements which can then be attached to one another. These individual elements of information are grouped, or associated into networks, webs, or stacks. The best known metaphor for such systems is the box of notecards. Each piece of information can be likened to what you might write or draw on a 3x5 card and then the way you go about sorting or stacking the cards aids you in accessing a specific card. Because the cards are individual pieces of information you can basically "shuffle" or reorganize them in any sequence you care to (see Halasz, 1988).

Individual nodes are connected through links. Links are manifested through hotspots, buttons or points on the screen. The links are indicated by an icon, alternate color, or other visual cue on the screen. The points indicate a link to some other node in the network and it is by way of these links that most users move around in the network. As you view a node the identified points are available to you via the keyboard or mouse. Because of these linkages and the associated points, the user has the ability to traverse or navigate through a wide variety of kinds of information in a non-linear way. This means that the individual can skip or jump around through the "information space" in ways which defeat a typical linear structure or even a two dimensional hierarchy. This navigational or browsing property is another of the critical features separating hypermedia system from more traditional ones.

Typically called browsing, this ability to traverse or navigate through the information in a nonlinear fashion is often considered the strength of hypermedia systems. Not only can a user move through a document in a "next frame/last frame" linear fashion but the active areas on the screen allow them to jump to different nodes. Some hypermedia systems provide a means of displaying the series of most recently viewed nodes or a map of where the user is in the network, or both, and from these you can move to any other node. Additionally you often have "search-for" or "find-a-string" capabilities which allow wide jumps in the network. Each of these options is used to move from "card to card" or from information node to information node. A great deal of research is going on relative to the nature of the database requirement for such systems, the nature of the kinds or types of linkages or nodes that are necessary or useful, and the requirements of supporting features such as browsing (Frisse, 1988, Halasz, 1988). One of the major interest areas for the application of hypermedia is the development and delivery of computer assisted instruction (CAI).

## THE FEATURES OF CAI

While early developments in CAI encompassed not much more than using the computer to "turn the page" of an electronic book, as a greater understanding of the capability of the computer have reached educational researchers and the findings from education research have reached the computer science programmer, more sophisticated environments using both the capabilities of the computer and some of the necessary features of good instruction have emerged. Among the desirable features of any effective instructional process (see Gagné and Briggs, 1973 or Merrill and Tennyson, 1977 among others) are:

- information in manageable pieces, lots of interaction (for motivational and active learning purposes),

- lots of feedback,
- individualization (both in pacing and in tailoring delivery to learning strategies or styles of the individual).

Good quality CAI attempts to incorporate these features in lessons delivered on the computer. The computer provides a vast capability to support these educational/instructional principles. Among the modes of computer use which fall under the umbrella of CAI are:

- drill and practice,
- simulation,
- tutorial interaction,
- games, and
- tests.

The typical algorithm implemented in current CAI systems is "present information, test, provide feedback, continue or recycle, loop". This is then repeated throughout the lesson. Advances from the straight "page turning paradigm" have largely involved branching schemes. An interesting facet of CAI programs is that they implement a basic linear or two-dimensional hierarchical view of information which is what hypermedia systems are attempting to move away from. Among the major benefits which are attributed to good CAI programs are:

Self paced — learners can progress through the materials at their own speed and can back up and review materials whenever they want.

Unintimidating — learners seem to be less threatened by working with and receiving corrective feedback from a computer.

Immediate — Computers are able to evaluate user inputs almost instantaneously and thus give feedback to the user very quickly.

Consistent — because the materials are stored in the computer each individual going through a lesson will see the same information.

Remediating — again since the materials are stored and retrievable, students can review a CAI lesson multiple times until they master the material.

Measurable — since evaluation exercises or tests can be embedded into a lesson, CAI lessons can then regularly assess learning that is going on by having the user go through assessment exercises.

## THE LIMITATIONS OF CAI

While CAI has been shown to be an effective means of delivering instruction, it still possesses some limitations. While an individual can control the pace with which they view the screens in a lesson, CAI still leaves something to be desired concerning flexibility and individualization of presentation. While a CAI lesson may contain sophisticated branching based on an individual's performance, typically there are still limited paths through a given lesson. Traveling the optimum path by never making a mistake on any exercise, providing remediation or branching based on incorrect responses, or providing suggested extra materials are really the only options available in CAI lessons. Control of the information display sequence remains totally in the hands of the program.

## THE ENTICEMENT OF HYPERMEDIA

On the surface hypermedia systems appear to encompass many desirable features useful in CAI. The organization of information into small, discrete units supports good instructional design principles. The idea of being able to reorganize information appears to support individualization of instruction. The navigation concept seems to support greater user control and thus individualization of instruction. The argument is that, through browsing, the user has greater control in viewing information and thus greater self pacing not only in terms of speed but also in terms of sequence. This user control is motivational as well as supportive of individualization. The ability to incorporate many diverse media provides the opportunity to develop much richer instructional alternatives. While these appear to be very useful concepts for CAI we must take a look at some basic limitations of hypermedia and some additional requirements for instructional systems.

## INSTRUCTIONAL HYPERMEDIA: A TWO-EDGED SWORD

While hypermedia systems provide a very rich environment for presenting information they still contain some limitations. One which is critical is that with large hypermedia systems users get lost. Without fairly elaborate aids, users moving around in large networks can easily get disoriented or lost. This has very grave portent for an instructional hypermedia system because of the possible impact on the learner. If users who are interacting with a system for the primary purpose of simply locating and retrieving some specific or related information can get lost, then what is the potential for users who are trying to "learn" something? This idea surfaces the critical area of the difference in purpose of current hypermedia and instructional systems. Hypermedia systems are designed to aid in information storage and retrieval and not to be tools to actively aid in a change in behavior which is the definition of instruction. For hypermedia systems to be molded into instructional systems, several basic features must be added. Primary additions fall into the areas of information management and learning evaluation.

## INSTRUCTIONAL INFORMATION MANAGEMENT

Information management in this context refers to the control of the sequence of information display and incorporating instructional intent. In CAI, this control is designed into the lesson hopefully based on good instructional design decisions. In hypermedia systems users have much greater control of how they want to navigate through the material. Control of the flow of information is a central point in educational research and the development of effective instruction. A critical difference between an instructional system and other information retrieval systems is that instruction by definition prescribes control over presentation for the purpose of supporting efficient learning. Hypermedia information control is almost the antithesis of instructional control. Some of the research issues related to instructional management in hypermedia systems include:

- How, or do, you control the navigation process?
- Do you limit navigation options from or to a specific node?
- Limiting navigation defeats the concept of a hypermedia environment but is considered crucial for instructional purposes; or is it?

With the use of the hotspot or button, hypermedia systems appear to give the user free access to moving anywhere in the network. But really in current implementations, navigation is controlled through the inclusion of the hotspots or buttons on a node and the associated link to another node. Thus the designer of the hypermedia systems is in control of the navigation process. While a user might make a jump to another node via a "search for" command most initial users use whatever hotspots or buttons are available on a node. This node/link process provides the instructional designer a much richer environment for associating learning materials but the appropriate use of such linkages and associations for instructional purposes needs to be researched. Additionally, the ability of dynamically including or excluding certain links based on past or current user performance is a must for effective instruction.

## LEARNING EVALUATION

Another critical element in good instructional design is ensuring that learning has taken place. This is typically done through some type of performance evaluation. This evaluation serves multiple purposes. First it provides a means of ensuring that the lesson imparts desired information to the learner. Second it provides both motivation and feedback to the learner. The ability to provide such an evaluation and feedback function in a hypermedia system becomes quite interesting. Since hypermedia systems allow the user to traverse via hotspots or buttons, there is a much more elaborate set of possible paths through a given amount of information. Because of this, the idea of conducting an evaluation over material covered by the individual becomes quite a challenge. If these buttons or branching alternatives are carefully designed (using information processing or other instructional theory) then what is needed is a means of tracking the user's path through the information and generating a unique test periodically or modifying a existing test such that it covers only the information the student has chosen to go through. Then appropriate feedback or branching, or both, can take place. Another aspect of this concerns total coverage of materials. In a CAI lesson a learner will eventually view all required "screens" and complete all of the test items. With the free navigational property of a hypermedia system, ensuring that an individual contacts all nodes and "learns" everything you want, becomes difficult. Additional research issues associated with this evaluation process include:

- What scheme to use for deciding when to interject a question (i.e. after X many frames?)
- Is it possible to develop a dynamic questioning process where questions are generated based on only the materials an individual has gone through?

An associated issue is: "How do you provide effective feedback to a learner?". Hypermedia systems are typically set up to support navigation and not other interactional properties, such as feedback (in the instructional sense), and yet feedback is a critical feature of an instructional sequence. How do you develop and incorporate feedback into a hypermedia environment?

## INSTRUCTION OPPORTUNITY WITH HYPERMEDIA

Hypermedia environments incorporating the instructional properties already discussed will provide a significant educational potential. Not only will such systems provide many of the features which CAI researchers have wanted for years (like easily integrated graphics, text, animation, video, and audio) but will also provide a means of investigating instructional issues which we previously have had little effect on. The easy integration of various media in one rich environment will provide a great opportunity to investigate the effects of any of these presentation options. Alternative branching schemes based on learner interactions may lead us to insights into learner and cognitive strategies. By providing learners very rich environments and monitoring their individual progress, issues including textual or graphical preferences as a function of content domain may become a tractable research problem. Also, by confronting individuals with novel problems and complex hypermedia environments which contain the solution, monitoring their navigation may provide insight into their approach to problem solving.

## SUMMARY

Does hypermedia possess the potential to be an effective instructional environment? Yes, but in order to do so some critical instructional properties must be added to the developing environments. Hypermedia systems may well provide the ability to overcome some of the limitations of current CAI. Some of the very features which make hypermedia systems so interesting for storing, retrieving and navigating through information appear to make these systems less then optimal for CAI. Having the user in complete control of the navigation through the information provides a powerful motivation to the users but places a great deal of difficulty on the instruction process. Basic ideas such as presenting prerequisite information first or going from easy to hard material can be totally defeated in a hypermedia implementation. Additionally how you provide interactions other than node selections or what you can do instructionally with the buttons or active areas is intriguing. These and many other features of hypermedia must be researched before we can say that hypermedia is effective for instruction.

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# INSTRUCTIONAL CONSIDERATIONS IN BUILDING EXPERT SYSTEMS FOR INSTRUCTIONAL DESIGN: THE HUMORS PROGRAM

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## ABSTRACT

The problem of education and training are so important, and their scale is so large, we almost immediately try out all of our newest technologies in their service. While many of the latest ideas appear useful, some just do not seem to be usable by the people who need them.

Researchers at Ford Aerospace are studying instructional-technology interventions from two perspectives: what technology can provide and what people can use. A family of expert systems is planned to span the curriculum-development process.

## HUMORS PROGRAM

The evidence suggests that the new technologies of instruction do not work. They are not, after all, solving our instructional problems. If they were, there would not be so many gloomy headlines and daunting indictments as there are.

Furthermore, these new technologies, like AI, IVD, and CD ROM, appear to be failing in much the same ways as their unsuccessful, unlamented predecessors: ITV, programmed texts, and CBI.

One unfortunately obvious pattern to this phenomenon is that the thrust of both the old and the new instructional technologies is commonly directed only at the technicalities of the technologies. Often this leaves the needs of instruction quite totally ignored. As soon as the touch-screen technology was invented, for instance, an aching need for fingertip interactivity was discovered. Now we ensure that fingertips are engaged, even if the mind wanders.

The promising capabilities of the new media too frequently are exploited--only for the sake of curiosity or novelty; they need to be applied--purposefully for the sake of teaching. We tend to view technology as a treat when we should be harnessing it as a treatment. For example, even the most ardent technophile readily will acknowledge that good __________ (Fill in the blank with your technology of preference.) does not, in and of itself, constitute good instruction. Indeed, second-rate __________ can be found to succeed as instruction, at least sometimes. The attributes carrying the effectiveness of instruction have always been technology-independent.

The attraction to technology-as-technology is fully understandable, nevertheless. Gadgets are neat. Gizmos are fun. They look great under the tree. They are real; you can touch them, pick them up, fondle them, brag about them, and immediately compare them to see whose is bigger. You cannot do that with "instruction," whatever that is.

While understandable, however, this technocentrism is unacceptable--at least as an exclusive orientation.

## A RADICAL PROPOSAL

By looking at the nature and needs of schools--as distinct from the capabilities of hardware/software systems, and, furthermore, even as distinct from the conditions of learning, Ford Aerospace has initiated the development of the HUMORS family of expert systems to inform and automate the tasks of curriculum development for the real world. Even though schools probably should not be run the way they are, that is where the students are. That is where the need for responsive technology is presented. That is where the help is needed. And that is not likely to change any time soon, not for the public schools, and not for the military services.

This uncommon point of view provides a somewhat different foundation for our enterprise than others have selected. It necessarily defines a somewhat different product.

Before proceeding to the particulars of how the HUMORS approach to expert systems works uniquely, it may be useful to consider its name. In addition to performing the obligatory acronymic function that engineering organizations demand, the HUMORS label recalls a 600-year-old, but still-useful analogy.

In the Middle Ages, physicians believed mental dispositions to be determined by the proportion of the four chief fluids, or humors, of the body. There was thought to be a definite, identifiable set of elements: blood, phlegm, choler, and melancholy. Each, and the mix of all, determined one's dispositions. While the humors most-often are associated with the diagnosis of illness, they were used to interpret and explain all manner of people's behaviors. In much the same way, it currently is held that mental dispositions--to learning, for our discussion--are determined by combinations of a finite set of discernable and measureable stages and styles of thinking. That means that scientifically planned instruction should address these factors which effect the elements of individuals' cognitive structures, the mental building blocks of expertise, what some have termed the "cognitive primitives" of schemata, or, retrospectively, cognitive HUMORS.

This is the first, and perhaps most characteristic element of the HUMORS approach.

## The Nature of Instruction

We hold that "information" is very much not the same thing as "instruction." Even though some instructional designers would seem to do no more than move words from pages to screens, then add blinking, it is obvious that this is not instruction. At best, it is information. Sometimes it is not even that. Telling a friend your new phone number is information, not instruction. Informing a classroom of high-school sophomores that you will conspire with their parents to make them miss The Big Dance unless they can demonstrate by fourth period next Friday that they have memorized the Periodic Table of Elements also is not instruction--at least not in chemistry.

What instruction is is a somewhat harder topic than what it is not, but studies into the nature of expertise make that a little bit accessible. Numerous researchers have worked on this issue, and they have established that expertise requires massive amounts of information and massive amounts of practice. The lower limit on the duration of practice has been put at 10 years. Immediately, that indicates that full-scale expertise cannot be the goal of instruction. There just is not enough time to devote 10 full years to each of the desireable topics. Rather, the proper goal for any instructional intervention is: the establishment of that readiness state that allows the learner to derive fullest benefit of the practice to be availed--for a particular point along the practice continuum, for a particular domain of knowledge. In easier words, it means: Instruction requires that the information of the discipline must be communicated to the learner accurately and meaningfully.

The accuracy of the information, almost totally, is best determined by the keepers of the discipline, the authorities, the recognized experts in the field--whatever the field may be. The meaningfulness of the information, on the other hand, is determined solely by the student. Since disciplines are easier to pretend to control than students, instructional product development historically has focused on the accuracy of information rather than its meaningfulness. As we have shown, that is a necessary part of the task. History shows that it is insufficient, however. Instruction also must consider that which is not the information. It must consider, and manage, the vehicles for conveying the information. It must identify which communication dynamic can be effective--now, for this message, and for this learner, who just happens to be in a difficult mood at the moment. And this introduces another variable of complexity. Any communication dynamic involves two entities, the transmitter and the receiver. Thus far, we have considered only the receiver and the needs of reception. They are complicated and diverse. But it gets worse. Not everything that a receiver wants to have transmitted as a message actually gets to be transmitted. Sometimes cost limits the scope or manner of the presentation. Sometimes less-objective considerations determine what is served up as instruction.

This introduces the second major assumption on which the implementation-oriented HUMORS family rests: As instruction does not ensure learning, schooling definitely does not ensure instruction.

### The Problem of Schooling

Rightly or wrongly, most planned-for learning activities, that is to say most instructional events, take place in the schools. But that is not all that takes place in the schools. In order to find its way to the students, any serious contribution to practice must also satisfy other requirements. An expert system for curriculum-development in the real world must be "useful" (i.e., instructionally sound) but that is not nearly enough. It also must be "useable"--within the physical, social, ethical and legal boundaries of the schools.

An expert system that advised teachers on instructional strategies could, conceivably, recommend a field trip. Field trips can make extremely effective instruction. They present the subject matter in its totality and in its context. They are accurate. They are meaningful to almost all students. They are also very rare in the real world, and they will stay that way.

Field trips will continue to be rare because they pose such an incredible implementation nightmare. They become onerous even before the actual trip begins. The challenge of coaxing all of the students to deliver the necessary permission slips, and all of the parents to sign up to one conclusion or the other, and then prod all of the students so they will remember to return their forms is enough to make a teacher give up the idea forever. If one hour of regular classroom instruction takes a teacher one (or more honestly one-half or one-quarter) hour to plan, one hour of a field trip takes ten hours to plan. Worse, they are physically arduous; some type of catastrophe always happens.

Here is another illustration. Many school teachers refuse even to imagine including films in any of their lessons. They know the projector's bulb will be burned out or missing. And they are not favorably inclined toward staying late or coming in early to go see the librarian who guards the key to the media closet.

It may be thought too cynical and radical, or downright peculiar, to imagine that anyone serious would consider building high-technology tools around such un-scientific vagaries. At least it may seem that way at first. On admitting the inevitability of these vicissitudes, however, the building of tools that will NOT accomodate the realities of schooling appears to be far worse than merely peculiar.

The problem is not limited to schools, either. Proposing that the new technology treatments are spared these human failings is not supportable. Professional curriculum developers face the same dilemmas.

One instructional designer friend, ABD from several well-known universities, knew the principles of his practice. He could recite them. He could even teach them. But when it came to following his own advice about depending on graphics to carry as much of his message as possible, he went right on using words. Thinking graphically is not a part of his cognitive repertoire. He knows that he should. And that is all.

In what must be a unique situation, another friend recalled a horror story of a customer dictating an instructionally inappropriate delivery medium!

That leads up to point number three of our underlying assumptions about what is needed from technology if it is to be responsive to real-world pressures.

First, a review of the first two. Point one is that information is not instruction. Telling the students or otherwise conveying messages that are factually accurate is just not good enough. The messages must be meaningful, and meaningfulness is individually determined. Regardless of personal preferences, different strategies are called for when attempting to teach the same content to different people.

Point two is that being instructionally sound is not enough. Effective contributions to instructional practice in the schools--where most instruction takes place, must satisfy more needs than only the instructional ones.

### Insufficiency of ID

Point three is that the body of knowledge generally referred to as Instructional Design is not capable of meeting fully all of the demands of the task. Instruction is not a "science."

Even if it was possible to know, absolutely, what instructional interaction would positively guarantee success for a particular student/subject/situation, it would be impossible to guarantee that the prescription would be implemented. That which is proferred as instruction, be it on-line or at the blackboard, still is influenced more greatly by the quality of last night's sleep than it is with the scientifically established principles of learning.

## THE HUMORS WAY

So far, one example of an HUMORS expert system has been built. That is TIPS, a tool for identifying appropriate instructional strategies for any domain of discursive, technical content. Others are planned. All will operate under the aforementioned assumptions, and in the following ways.

### The Wisdom of an Information-Independent Knowledge Base

The HUMORS systems are intended to serve people who are experts in technical disciplines other than instruction. It is this type of person who represents the most typical customer for Ford Aerospace's Instructional Systems Department; it is an obvious focus for our R&D activities. These SMEs (subject-matter experts) often face the problem of staffing shortfalls with no one to turn to but themselves. It is they who must take on the responsibility of preparing the new trainees for demanding jobs. While they are more convinced than anyone of the importance of the instruction, they are often unsure about how to do it or the form it should take. Should it be tough, disciplined, no-nonsense Training? Is the greater breadth and farther reach of Education more appropriate for solving the unanticipated problems that come up every day? What about this CBT stuff that gets so much attention? Is there any substitute for The School of Hard Knocks? Curiously, these SMEs carry the answers to all of these important questions. They literally embody the answers, even though they might not be able to write them down on a piece of paper.

Regardless of what words or technologies are used, these SMEs are the ultimate goal of instruction. The whole point is to make more people more like them. If the SMEs are incapable of writing long-winded treatises on how they solve dense problems, it probably will not matter. (This does suggest, however, that such an evaluation methodology is an artifact only of schooling and, therefore, unnecessary as preparation for students. Un-fair too.)

Studies of chess-playing, taxi-driving, money-changing, and even equipment-operating and -maintaining expertise indicate that the wisdom-memory of true experts is different from the knowledge-memory of the passably fluent, and both are markedly different from the information-memory of the neophyte. The cadences are different. Even when these different levels of incumbent trace the exact same steps, what they "do" is importantly different. It is this difference that the HUMORS systems address.

HUMORS attempts to ascertain the cognitive structure of the experts' view of the discipline, and to work toward that as the idealized goal state. It does so by asking simple, straightforward questions about the SME's domain of expertise. He depicts his knowledge to the system by answering these multiple-choice questions. The system interprets this depiction in terms of general elements that serve to make up one's cognitive structure. That version of a cognitive goal state is what informs the decision-making advice that is the system's final output. Exact steps are not recommended in HUMORS. Rather, a general goal state is defined, and then categorical advice, advice that must be individually interpreted, is provided.

This categorical approach avails two strengths: the de-contextualization from a unique domain precludes the interference of jargon, which should be clearly desirable; the second strength is that, by dealing with mental structures for learning instead of technical content, HUMORS can span a greater range of instructional problems. This feature is not as popular with everyone.

There is a strong tradition of academics defining the "structure of the discipline" for their students. Until fairly recently, many schools of education followed this lead, offering courses like "Methods of History Teaching," "Methods of English Teaching," "Methods of Mathematics Teaching," and such. There was a "methods" course for every department, suggesting that the topography of epistemology was isomorphic with the campus map--minus the

Dean's office. For the purposes of planned instructional events, that no longer seems to be required.

It probably is the case that the highest reaches of any discipline do have a distinct, identifiable cognitive structure that warrants an individualized treatment. But the only way any real, live practitioners ever get to those planes of accomplishment is through a long, personal and individualized apprenticeship after years of formal schooling. As was discussed in an earlier section of the paper, full expertise is not to be achieved through instruction alone. Full expertise is not the goal of instruction. HUMORS does not purport to deliver full-scale expertise. Rather, it simply seeks to establish the general structure of SMEs' expertise so that structure can define the point that, through instruction, the student will move toward.

To define the SMEs' cognitive structure, HUMORS takes off from Robert Gagné's seminal, domain-independent Outcomes of Learning, with modifications deriving primarily from Immanuel Kant and Edmund Husserl for a cognitive, constructivist orientation.

## Implementing Free and Informed Choice

Chris Argyris, the intervention theorist, has argued that there is no truly free choice that is not adequately informed. Increasing real freedom by informing choices is one of HUMORS goals.

The system's advice comes out as categorical statements for the individual user to interpret and implement. These are focused statements about the particular problem area (e.g., instructional prescriptions, evaluation methodology, authoring) but they cannot be acted on without being realized in additional detail by individual human beings.

In the spirit of Argyris, other intervention theorists might argue that there is no point even attempting to implement anything other than free choice. The only thing left clearly is impossible. Just watch a classroom teacher the instant her supervisor closes the door on his annual visit. She is going to do just exactly what she, herself chooses, not what he mandates--even if theory is on his side.

Every well-intentioned practitioner (instruction or otherwise), given a choice and a chance, will do what s/he thinks is best--regardless of what others may think, and often regardless of the rules. It may be comforting to imagine a different scenario, but that is all it would be: an imagination.

Building expert systems with such a Puckish nature seems dreadfully unscientific. The desire to resist that choice is understandable. Nevertheless, it is the irrepressible and undeniable case that the schools, including instruction, are beyond the control of laboratory conditions; every other conclusion about the requirements of responsive technologies is folly or conceit.

Only an approach like that of HUMORS truthfully can be called systematic. Others recall the Danish philosopher Piet Hein who observed that, "You can cut so much off a problem, it no longer resembles itself."

HUMORS acknowledges the irregularities of free choice and informs them with instructional theory. Through the typical "Why" and "Help" capabilities expert systems offer, HUMORS explains the meaning of its advice and teaches the SME how he can implement the advice.

The freedom HUMORS supports also allows the human user to consider a range of implementation factors so wide that no computer tool would be able to anticipate them all. It is not feasible, if practicable, to program a system to think about the limitations of handling classified information, even though this is of the first priority. Only humans reacting instantaneously can properly determine what to do with un-stable information. No one can predict everything important that is likely to come up. That is better left to the humans--with stable, informed advice that leaves room for their tailorings.

## The Limits of ID

Systematizing beyond these bounds is not justified. Instructional Design just will not carry you that far. This has been proven dramatically and repeatedly by personal experience, by both authors. On numerous, numerous occasions in the past, both of the authors, individually and together, have managed to learn from an instructional delivery (human and otherwise powered) system that was literally anti-instructional. Similarly, both of us, individually, and together, have readied absolutely dazzlingly exciting and theoretically inspired lessons that the lazy ruffians sent to us against their will did not like or learn from.

Classroom observers cannot fail to marvel at the instant of intellectual recognition when a lesson all of a sudden comes together for a student. Finding the essential component to the victory is obviously an artistic, not merely a scientific pursuit, because the instants are all different, and what works Tuesday may be no good at all on Wednesday. We ought be scientific enough to admit this.

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# LCS's and Video Projectors:

## Lights at the End of Your Terminal

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### ABSTRACT

This paper discusses the four problems that arise when video projectors are used to project computer information onto a screen. Solutions are suggested for each of the problems.

With the increasing use of computers in education, teachers are bringing the computer into the classroom to show various programs and procedures. However, there is a continuing problem of being able to display readable computer information to the students. This problem is composed of four problems: 1) selecting the type of projection device needed, 2) computer to display compatibility, 3) readability of the display, and 4) control of the room lighting.

### TYPES OF DISPLAYS

There are three types of computer information displays that can be used with a group. These are monitors, video projectors and LCD (Liquid Crystal Display) panels. The monitors are generally the poorest method of displaying computer information to a group. In a class with 20 or more students, at least four monitors are needed. These monitors must have a resolution high enough to display 80 characters. These units can easily cost over $1,000 per unit. If these monitors were not mounted, a safety problem could arise from the wires trailing on the floor from the monitors to the computer. To hang these monitors could cost between $500 to $1,000 per monitor. A minimum cost would be $4,000. For a safe installation with the monitors hung from the ceiling, the cost could easily exceed $6,000, and the displays would still only be low resolution color.

Two other types of displays do exist--monochrome and color. If color is needed, the only answer is the color video projector. Kodak has introduced a color projector using LCD's. This projector weighs 13 pounds and seems to provide both good low color resolution and ease of use. There is the problem that the projector will only show output from a CGA (Color Graphics Adapter) video card. Since more programs are requiring the EGA (Enhanced Graphic Adapter) card or will only provide access to their more advance features using the EGA card, the best solution is still the three tube video projector.

The three tube video projectors that will project computer information have a starting price of $6,000. Video projectors should be hung in a room which can add $2,000 to the cost of the projector. The reasons for hanging the projector are the size and weight of the units and the focusing and convergence problems when setting up the units. The minimum weight of a color video projector is around 70 pounds and can easily exceed 100 pounds with high quality glass lens. These projectors come in cases that are at least two feet wide by two feet long by a foot high and have no handles. Thus, they are very cumbersome to move around and require at least two people to move them. An obvious solution is to place a projector on a cart. This solution is only good for movement within a building. If you try to go outside of a building, you will probably dump the projector onto the concrete sidewalk.

While the cart provides a solution for movement within a building, this solution does not address the second problem of focusing and converging the units. To get the picture focused on the screen, each of the three color images must be focused while trying to get the images to exactly overlay each other--to converge. This process can easily take from one to three hours. While the electrical and mechanical convergence stability of video projectors has improved, there is still a need to "tweak" the focus and convergence at each showing. This can easily take 30 minutes to accomplish. If the screen size varies from one showing to another, the whole focus/convergence process must be done again. The best solution is to commit one projector per classroom at a cost of between $8,000 to $15,000 per classroom.

If you do not need color, there are two other options--monochrome video projectors and LCD panels. The minimum cost for a monochrome video projector that will give an 80 character display is $3,000. Since the maximum cost of a LCD is $2,500 with most of the units costing in the range from $1,000 to $1,800, cost alone would seem to dictate the use of a LCD panel.

There is another reason to use a LCD panel. The monochrome video projectors have less light output than do LCD panels. This lack of light output requires a room that is so dark that students will not be able to take notes. Special high reflective screens can be used, but the problems with these screens outweigh the advantages. These will be more fully discussed in the section on room lighting. Because of the cost and brightness considerations, the best selection for displaying monochrome computer information is the LCD panel.

## DISPLAY COMPATIBILITY

The next problem area is the compatibility of the display device with the computer. The first aspect of this problem deals with the type of computer video output that is being used--composite video, Hercules monochrome, CGA, EGA, PGA, VGA, or a CAD display. Problems result from the different plugs used by the video outputs, the horizontal frequency of these outputs, and the range of the incoming frequencies that the display devices can accept. These frequencies start at 15.1 Megahertz for CGA outputs and can exceed 60 Megahertz for CAD (Computer Aided Design) outputs. Display units can handle one and maybe several of the frequencies but usually not all. The larger the range and the higher the frequency a unit can handle, the more expensive the unit will be to purchase.

Unfortunately, just because a unit should handle a particular type of output, it may still not do so. This results from no set standard on how to wire the plugs on the video output boards. It is possible to find plugs that are wired differently on the same make and model of a computer. This can require a specially wired cord for each computer that will be used. The cost of these cords can easily exceed $25 per cord. Do not assume that because a particular computer worked once, it will work the next time unless you have control of the computer to ensure that its video output board has not been changed. This happened at Purdue. Between the test and the use, the video board in the computer was changed, and the new board would not work with the video projector.

A good investment is an interface box that can overcome some of these incompatibility problems. These boxes can cost several hundred dollars, but they are a very good investment to help insure that the projector will work with each type of computer. These interface boxes are required when Apple computers, IBM or compatible computers, and video recorders are all going to be fed into the same projection unit. Unless large amounts of time are to be expended resetting the projector for each type of use, an interface box is required for each type of input.

LCD panels present another aspect of this problem. LCD units, at the low price end, map each color into either black or white. At the upper price end, they may map each color into shades of gray. Failure to test a color presentation on the unit that is to be used may result in a display that is either all black, all white, or with some of the color variations missing and with only some or none of the information present.

## READABILITY OF THE DISPLAY

The readability of an image is mainly determined by the size of the image. With regular audiovisual materials (e.g., 35mm slides and 16mm film), the minimum width of the image should be equal to at least one sixth of the depth of the classroom. A 36 feet deep classroom would need an image that was 6 feet wide. It is also recommended that these media do not exceed 40 characters per line. To handle computer information with 80 characters per line, the screen (image) width should be at least equal to one fourth the depth of the room. This is a 50 percent increase in the width of the screen. In a classroom that is 36 feet deep, this would require a screen 9 feet wide. Since the video image has a ratio of 3 units high to 4 units wide, the height of the screen would need to be 7.5 feet high. This could create a problem since the bottom of the screen should be at least four feet off the floor. Thus, the classroom would need a ceiling height of at least 11.5 feet which is at least one foot higher than the ceilings in most classrooms. The usual compromise is to put the bottom of the screen closer to the floor resulting in the students having difficulty reading the information at the bottom of the screen.

The picture size listed in the specifications of a video projector is given for the diagonal size of the picture. If the maximum specified size of the image for a video projector was 10 feet, the width of the image would be 8 feet. This size of image would be usable in a classroom that was 32 feet deep. Since most classrooms are deeper than 32 feet, the above projector would create a readability problem for the students.

The above readability problem can be improved somewhat by increasing the quality of the image. The quality can be increased by moving from CGA to EGA output or by improving the quality of the lens by using a glass lens instead of a plastic lens. Both of these solutions cost more money, and the exact improvement in the quality that will result is hard to determine. It is mandatory to test the actual equipment to be used in the actual facilities to be used or a very good approximation of these facilities. Do not assume, test!

## ROOM LIGHTING LEVEL

The lighting problem arises from the need of students to take notes during a presentation. For students to take notes, there needs to be adequate lighting in the room. Any light in the room decreases the apparent brightness of the image making it harder to read the image. With video projectors, it is generally best to have no lights in the classroom. This is especially true with color video projectors. Because of notetaking, this is an unacceptable solution. If there is going to be lights in the classroom, the lights should be down-lights in cans in the ceiling that direct the light onto the students writing surfaces and not onto the screen. If some light spills onto the screen, it should be as little as possible. If color is not needed, LCD panels which are much less sensitive to light can be used. However, lights still need to be controlled and have as low of level as is possible. It is best that the light on the screen be less than 10 foot/candles with LCD displays and less than 1 foot/candle with color video projectors.

Highly reflective screens can be used to overcome the light problem, but they add several other problems. First, highly reflective screens narrow the viewing angle. Most of these screens have a viewing angle of 90 degrees as compared with 170 degrees for a screen using matt white fabric. Outside of the proscribed viewing area of a highly reflective screen, the image will be dim and unreadable. This unreadable area may, in a regular classroom, eliminate as much as one third of the seats.

The second problem is the durability of this type of screen. Highly reflective screens are generally very delicate. They are very easily damaged, and this damaged area can create a spot on the screen where the image cannot be seen.

The third problem is the cost of these highly reflective screens. They are very expensive when compared with a screen using a matt white fabric. A highly reflective screen can be between 2 to 8 times as expensive as a screen using matt white fabric.

A final problem with highly reflective screens is that the screens are limited in the size that can be purchased. Often, the maximum size of the screen will only be 6 feet in width. This can severely limit the size of the class that can view information on this screen. Thus, it is better to use regular matt white screens and control the light level in the classroom.

## SUMMARY

In conclusion, this paper has discussed the four problems associated with using video projectors and LCD panels to display computer information to a class. These problems dealt with: 1) the selection of the type of display device, 2) the compatibility of the display device to the computer to be used with it, 3) the readability of the displayed image, and 4) the need for lighting control in the classroom. The best suggestion is to use LCD panels projected onto a matt white screen in a room with lighting control--if color is not needed. If color is needed, a three tube video projector should be selected. Again, the image should be projected onto a screen using matt white fabric in a classroom with lighting control. Also, check that the display device will work with the actual computer that is to be used in the presentation. Also check that the resulting image is large enough to be readable in the classroom in which the presentation is to be made. Taking these precautions will ensure that the selected display device will truly be the light at the end of the terminal and not an information black hole.

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# Converting Existing Text Documents to HyperText

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## Abstract

*The authors developed an approach to converting structured text documents to hypertext. They devised methods to restructure existing text for import to hypertext with a high degree of automation. Techniques were developed to automatically create indices and hypertext links. The specific documents contained law briefs, but the methods can be used to convert documents such as directories, manuals, and catalogs.*

## Introduction

Many existing text documents contain embedded structure such as tables of contents, chapters, headings, subheadings, and indices that help to convert the document to hypertext. A full text document of legal briefs on Pennsylvania school law was converted to a HyperCard stack at Lehigh University's Educational Technology Center. The original text was analyzed to determine its underlying structure, then a complementary structure was designed for the hypertext document. An import procedure was designed to avoid rekeying any of the text, and the original document was massaged to conform with the automated import procedures. Flexible indexing procedures were created and content-specific icons were designed to enable both the novice and the expert find the information they need. A stack management system was devised to enable yearly updates to be imported automatically. The final hypertext document, well over one megabyte in size, was optimized for and distributed on CD-ROM. The method used is generalizable to the conversion of other types of structured text documents, such as policy manuals, training manuals, courseware manuals, curriculum guides, resource guides, directories, and course catalogs.

## Hypertext Background

A number of hypertext-like programs for microcomputers have gained recent attention, among them *Guide*, *HyperCard*, *Ask Sam*, and *Linkway*. Each program offers a unique implementation of part of the hypertext philosophy, but none of them define "hypertext." Fidero (1988) offers a helpful definition:

> Hypertext, at its most basic level, is a DBMS that lets you connect screens of information using associative links. At its most sophisticated level, hypertext is a software environment for collaborative work, communication, and knowledge acquisition. Hypertext products mimic the brain's ability to store and retrieve information by referential links for quick and intuitive access. (p. 237)

The design of any hypertext document is governed to some degree by the hypertext environment in which it is implemented. The law briefs project used HyperCard, but many of the design considerations would have been similar with any hypertext environment.

## The Original Document

School officials, solicitors, and lawyers involved in education litigation need up-to-date information on judicial interpretations of school law as expressed in the decisions handed down over the years. Indeed, changes in the law are decided as much by judgement and precedent as they are by legislation. For that reason the *Pennsylvania School Law Briefs* (Fleisher, 1985, 1987) have been published by a professor at the Lehigh University College of Education. The briefs form a concise reference to decisions dating back to 1972 that affect the interpretation of education law in Pennsylvania. Unfortunately, the expense and difficulty of use of the printed volumes have precluded their use by many teachers, parents, and other interested groups.

The briefs are organized by a brief number that is the primary key, or index, to the primary topic and domain of the case. Topic tables of contents refer the researcher to a specific brief number. So that a researcher can find all relevant cases under one brief number, the brief numbers are not unique. There is also a litigant index that is used to find the case(s) involving a particular plaintiff or defendant. Updates are published in separate volumes, much like *Dissertation Abstracts* or the *Reader's Guide*.

A problem was recognized as the second volume neared publication. As the number of law briefs expands and the resource becomes potentially more valuable, it also becomes harder to use because the briefs span several volumes. Because each volume is separately indexed, each volume must be searched individually. For this reason it was decided that an updatable database may be an appropriate media for the publication. The primary users of the law briefs are lawyers and administrators, both of whom may have limited computer skills. Since a traditional database cannot be easily browsed or flexibly indexed, it was decided to use the medium of hypertext. HyperCard was chosen as the specific software for several reasons:

- the ease of use of the Macintosh provides a shorter learning curve for users;
- the front end of the database can be customized to allow use of the database by persons with little computer experience;
- it is economical, since HyperCard is distributed free as system software; and
- it is compatible with CD-ROM.

The document had grown beyond the capacity of a single diskette so it was decided to distribute the HyperCard stack on CD-ROM. Economical duplication and distribution of CD-ROM is now feasible if there is a reasonable base of subscribers—as few as one hundred.

### Determining the Existing Text Structure

The law briefs resided in about twenty-four Microsoft Word word processing files that were formatted for printing camera-ready copy with a laser printer. For each printed volume there was a file containing the table of contents for the ten main topics (see table below), a file for the litigant index, and ten files containing the briefs and topic tables of contents (twelve files per volume). The topics in the tables of contents were composed of keywords that experienced solicitors and lawyers would expect and would understand.

Clearly, each of the ten topics formed a major division, and the minor divisions were determined by the tables of contents. Indexing by litigant would have to be supported. Each brief had been formatted similarly, so there were already some obvious divisions of the text into fields and records. (see sample brief below) Each brief would be considered as one database record, and the various common items making up each brief would be fields in the record.

**Law Brief Categories:**

| | |
|---|---|
| 0000 | Government |
| 1000 | Administration |
| 2000 | Program |
| 3000 | Professional Employees |
| 4000 | Nonprofessional Employees |
| 5000 | Pupils |
| 6000 | Finances |
| 7000 | Property |
| 8000 | Operations |
| 9000 | Relations |

Special characters such as returns, tabs, spaces, and others are usually used to format or separate the structural parts of a text document. These characters can often form the basis of an automated process to convert the text document to a database or hypertext document. In each law briefs volume, for example, there were usually three briefs to a printed page. The files sometimes contained "new page" characters between records and sometimes did not. A "new page" character is a nonprinting character similar to a space or a return character. Occasionally, if a brief spanned two printed pages, a new page character appeared within a record, rather than between them. No tabs were used in the text files; some "fields" were separated from one another by one or more return characters. Other fields used multiple (varying between 20 and 40) spaces as separators. (This variation caused time-consuming, but surmountable problems.) Records were separated from one another by multiple return characters, generally three or more. The tables of contents used tabs, but the tabs were of different lengths for different levels of indentation, rather than using additional tabs for greater indentation. In other words, the number of tabs did not correspond to the topic level in the tables of contents. (This anomaly would prevent automatic conversion of the tables of contents.) The existing structure would be used to help determine both the appropriate hypertext structure and the automated conversion procedures.

### Determining the HyperText Structure

The hypertext structure would include not only an organization for the data, but also an organization for indexing, searching, and navigating through it. It was decided that most of the original data structure would be maintained in some form, since the printed structure had evolved to a fairly sound way of organizing the law briefs. Each brief, or record, would become one hypertext node—one HyperCard screen, or "card." Each kind of information in the brief would become one field on the card. There would be fields for the brief number, brief date, defendant, plaintiff, title, and descriptive text . Each field would be searchable independently, and it would appear in the same location and in the same text style on each card to provide cognitive consistency.

The first significant problem was to decide whether to make one large stack containing all ten topics or to create ten separate stacks joined by hypertext links. This major design decision can be an agonizing one; each approach offers unique advantages and disadvantages. (The stack organization is so fundamental that, once determined, it cannot be changed without starting over.) Separate stacks maintain the independence of the topics, facilitate searching a specific topic, have faster response times to topic-limited searches, and directly reflect the organization of the data. A single stack is more stable to copy and distribute, more usable for someone untrained in the ten legal topic divisions, and more searchable for cases that cross traditional topic boundaries. It was decided that the distribution and search integrity provided by one large stack outweighed the advantages of separate linked stacks. A method was now needed to keep the topics separated within the large stack. The chosen solution was to create a new field to contain the brief topic. An alternate approach of creating a separate "background," or substack, for each topic was rejected on the grounds that searching would be more easily managed with a single background for all briefs. The indexing problem was not solved so easily.

For reasons based upon differences in users' search methods, both the litigant index and the topic tables of contents would be preserved in the hypertext design. The litigant index, for example, provides a straightforward method of searching for a specific brief since cases are generally referred to by litigant names, such as *Brown vs. Board of Education*. In contrast, users with legal training may prefer the tables of contents, since they identify groups of briefs by known keywords. An additional means of searching is necessary to enable search across topic boundaries and also to enable those with less legal training to use the stack successfully. Therefore, an indexed full-text search on arbitrary keywords would be implemented to dramatically increase search speed and to permit boolean searches. Since boolean searches are not directly implemented in HyperCard at this time, a third-party "search engine" was used. The multiple indices were expected to offer significant advantages over the printed publication in searching for information. Some design decisions were determined by the particular strengths and weaknesses of HyperCard. For example, the indices would occupy separate cards on backgrounds that were different from the briefs so that a search begun from an index could be forced to "hit" on a brief card, and would not "hit" on an index or management card. It is important that the hypertext structure corresponds well to the data, the user, and the database program.

## Preparing the Text for Automated Conversion

Most database programs support the import of text files that meet the following criteria: (1) The file contains only printable ASCII text characters, spaces, tabs, and returns; (2) its records are separated by returns and (3) its fields are separated by tabs. There are other common combinations of delimiters, using commas, spaces, or only return characters, but the general import technique remains the same.

The first task in preparing the text was to convert the word processing file to an ASCII text file. Microsoft Word lets you simply "save" the file as a text file; other programs may require you to "print" the document to a file, or to "export" the document or data. Now the file, composed of only text characters (no control characters or other non-printing characters except for spaces, tabs, and returns), must be "cleaned up." Every record must be separated by one, and only one, return character. Every field must be separated by one, and only one, tab character. There may be no extraneous returns or tabs.

Global search and replace was the main technique used to clean up the text files. For example, some of the fields were separated by a variable number of twenty to forty spaces, which had to be replaced by tabs. The search located occurrences of long strings of consecutive spaces and replaced them with tabs. Then occurrences of tabs followed by spaces were replaced with just the tabs. This search and replacement was repeated across the documents several times until all the replacements were made. Similarly, all multiple strings of returns were reduced to a single return character that signified the separation between records.

One error was the replacement of the new page character with a return. If the file had been carefully examined in advance, we would have noticed that the new page character was used to break long records at page boundaries, as well as to separate records into pages. We should have searched for a combination of return and new page characters (and replaced then with returns) to denote page breaks between records, and then handled the remaining new page characters as exceptions to be replaced individually. A sound practice is to thoroughly examine the source files for unexpected characters, and then to thoroughly examine the converted files to be sure the conversion was successful.

With the exception of the new page characters, all formatting of the delimited text file was accomplished algorithmically. The algorithms were expressed as repeated search and replace commands across each entire file. Although this was implemented through the word processor's search and replace command, the procedure could be efficiently implemented in a BASIC or Pascal program that would apply each search and replace step rapidly to each file. The word processor search and replace command was a valuable exploratory technique because the results of each step were visually apparent immediately. Missteps could be easily undone with the word processor's "undo" command. A program would be written to do the cleaning up only after old file structure and the new file structure were thoroughly understood. Although the new page characters created the only anomaly that had to be dealt with on a per record basis, the preparation of the clean, delimited ASCII files was a time-consuming process. When the text files had been successfully delimited, they were ready to import into HyperCard.

### Importing the Structured Text

HyperCard and most databases support the import of delimited text files. Some databases allow import only during database creation, while others allow import only into a database with previously defined fields. When a delimited file is imported, a tab or comma forces the next data item into the next database field, and a return forces the the next data item to begin a new database record (or "card" in the case of HyperCard). HyperCard has a built-in programming language, HyperTalk, which was used to create an intelligent import "command." The import command was placed into a "button," a feature of HyperCard that allows a sequence of commands to be invoked by clicking the mouse on a region (called a button) defined by a name, a box, or an icon. The import command was written with three interesting features:

- the records of each imported file were *appended* to the HyperCard stack, maintaining their order.
- each imported field was assigned to its correct field on the card during import, and
- a "topic" field unique to each imported file was added to each record during import.

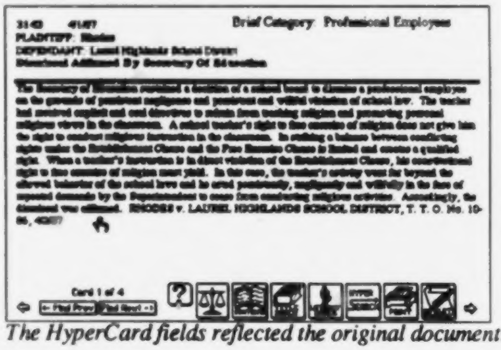
The "topics" field helped to maintain the integrity of the ten original categories that had determined the original organization of the law briefs.

The actual importing of the delimited text files into HyperCard was the least time-consuming part of the whole project. Next it was time to format the data for readability and aesthetics.

### Formatting the HyperText Data

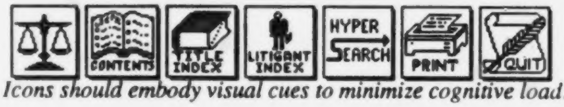
When the files were imported, each record was placed on its own card, and each field was placed in a HyperCard field. The actual format of the fields on the cards was not defined in advance because we wanted to keep the design flexible until the "fit" of the data into the fields and the fields on the cards could be visually judged. Since HyperCard does not strongly "type" its fields according to kind or length of data, it didn't matter that this step was done after we could see how small or large each field seemed. Although we could have defined a field as a scrolling field to accommodate large quantities of text, it turned out that the data from the largest record just fit comfortably on the card. We felt that avoiding a scrolling field was advantageous for a cleaner user interface, and also because the hidden portion of the scrolling field could not be as easily printed as the visible part of the card.

The fields were formatted by dragging them around on the card and resizing each one until a visually clean and cognitively clear format was achieved (see sample card below). The arrangement of fields was similar to that of the printed briefs so that it would feel familiar to someone used to the printed product. The most important fields were boldfaced, and typefonts were chosen with two criteria in mind: (1) the type had to be very easy to read on the Macintosh screen (therefore fonts and sizes had to be chosen that would reside in most Macintosh systems); and (2) the type had to print in high quality on the laser printer (so only "laser" fonts that were highly legible on the screen could be used). Each field was a defined as a "background" field; this meant that a change made to the position or format of a field on one card was applied to that field on every record.



*The HyperCard fields reflected the original document.*

The bottom region of each card was reserved for icons to be used for navigating, searching, printing, and other essential functions. The menu bar was hidden to avoid confusion, so that all commands or activities were to be activated by clicking the mouse on buttons associated with the icons. Icon design turned out to be another time-consuming tasks. An icon must visually communicate its purpose in such a way that it is an easily remembered, unambiguous visual cue. The most important icons were the search and navigation icons, and they had to be designed to be congruent with the index structure of the HyperCard stack.



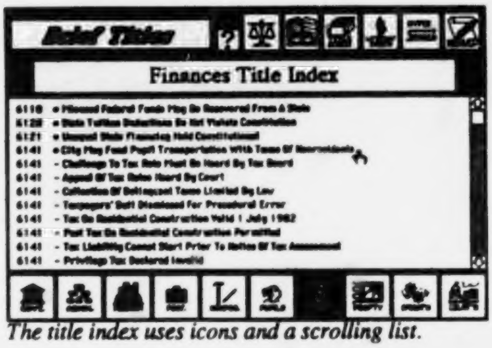
*Icons should embody visual cues to minimize cognitive load.*

## Indexing the HyperText Data

Small HyperCard stacks are typically navigated by browsing, but browsing as a method of finding information breaks down rapidly as the size of the stack grows. The most common method of finding information in a larger hypertext document is probably through an indexing or contents system. The index structure that was created for the hypertext document would determine the method by which the stack would be searched, and secondarily, how the stack would be navigated. The indexing schema was pre-defined to a degree by the indexing of the printed law briefs. The printed briefs had tables of contents by brief number, topics, and subtopics. The brief number was the primary indexing key. The printed briefs also had a litigant index which cross-referenced defendants and plaintiffs to their specific briefs. The printed briefs could be "browsed," or paged through, and the stack was designed so that a similar type of browsing was supported. Browsing is helpful as a simple way of finding information *related to* an indexed node. Finally, a full-text keyword search method was needed. HyperCard has a fast "find" command that can be flexibly used, but it does not support boolean searches. A commercial external command (XCMD) that supported full-text boolean search called *HyperSearch* was purchased and installed into HyperCard as a resource.

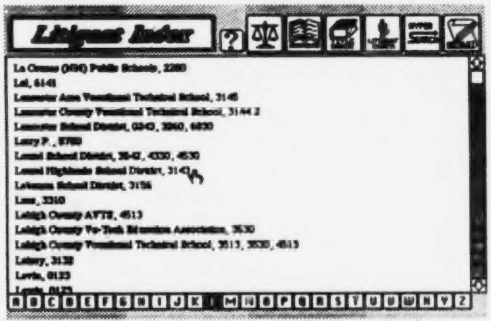
This XCMD created an inverted index of the words found in the text. This inverted index is a common method of quickly searching full-text selections, but it adds considerably to the total size of the hypertext document. The 1250K HyperCard stack produced an inverted index of 550K, increasing the total size nearly 50%. Since the final version would be distributed on CD-ROM, the size of the document was no problem in this case. For distribution by floppy disks, the inverted index would have considerably aggravated existing disk capacity problems.

Each index was created in a way that suited its kind of information. The table of contents index had to be created partially by hand because of the multiple-level indents with tabs of unequal length and because of the arbitrary brief numbering scheme. The indices reside on special "index cards," as opposed to data cards. To avoid long, scrolling lists, each index was chunked into an amount that would comfortably fit on a card with minimal scrolling. For example, the table of contents for each topic was placed in a scrolling field on a separate index card. A button with a representative icon is used to select the main topic, whereupon the scrolling list for that topic appears, and any other topic list disappears. A highlighted icon and a topic title inform the user of the current topic.



*The title index uses icons and a scrolling list.*

An alternate method was used to create and to chunk the litigant index. The litigant index was compiled automatically by scanning each card and writing the contents of the card number, the plaintiff, and the defendant fields to a scrolling field in the litigant index. Since it was to be alphabetically ordered, the litigant index was alphabetically sorted and chunked into alphabetic fields much like an address book or a library card catalog. Buttons are used to select the letter of the alphabet, and then the scrolling field appears for that letter or letters. All other litigant fields are invisible until exclusively called in this manner. The user can change to litigants that begin with another letter by clicking on the button containing that letter.



*The litigant index is alphabetically organized.*

## Linking the Data—the "hyper" step

Hypertext implies the freedom to search, browse, and otherwise navigate through text in a non-linear, arbitrary manner. In traditional hypertext terminology, links are established between nodes such that nodes may be traversed in non-linear ways. Hypertext links were established through several methods in the HyperCard school law stack:

- hard links were established between specific buttons and specific index cards;
- soft links were established between each index item and the card, or cards, to which it refers; and

- navigational links were provided for relative moves to the next card, the previous card, or the last index card visited.

Hard links are individually preprogrammed into the stack by the HyperTalk programmer and do not change as the stack changes. Soft links are dynamic; they can be created "on the fly," and they can change as the stack changes. The soft links are created by a look-up procedure programmed in HyperTalk. The soft links behave as follows. A user wanting to view a particular brief number, topic, or subtopic would do so from an index card by clicking on the line in the table of contents scrolling list that contained the desired reference. The program would identify the clicked position and then parse the line into subtopic and brief number. It would then move to the first card with that brief number.

A similar kind of soft link was programmed to work with the litigant index, but there was an additional problem. Since there may be several non-contiguous briefs for a particular litigant, a list of brief numbers was collected from the clicked line, and the cards could be displayed in sequence at the user's discretion.

A user could add any displayed card to a list of briefs to be printed by clicking on the print icon, or she could choose to have the card printed immediately. From any card, the user could click an icon to navigate to any of the indices or to the search specification card for boolean full-text searches. The full-text search made possible by the inverted index was a fast and highly effective means of searching for briefs whose indexing keys were unknown, or to search across main topics. This approach is more of a brute-force technique than a hypertext technique in that everything in the document is indexed. The creation of intelligent or logical links is more in keeping with the hypertext philosophy, although the inverted index is a valuable addition.

## Hypertext Management Tools

The law briefs project is an exemplar of a group of documents that are periodically updated. The updating process can be made much less painless if it is incorporated into the hypertext design. Several techniques were developed for the management and updating of the school law briefs stack:

- A "hidden" management card was created to handle all stack management functions. The management card contained several buttons with scripts designed for the updating process.
- An import button was kept in the stack to allow for the importing of updates.
- An indexing button was kept in the stack to allow for the automatic indexing of newly imported data.
- A hidden field was created on each card to aid in sorting the stack into its correct order, and a sort button was created to resort the stack after updating.
- A button for global deletes was placed on the management card; global deletes are necessary if an anomaly occurs during file import or if updated information partially replaces old information.

Any tool as powerful as the management card cannot be available to the casual browser. For that reason, it was created as a hidden card; no available navigation button can display the management card. A reasonable improvement for the future would be to password-protect the management card.

None of the functions of the management card are necessary for the casual user. Nor are they necessary if the stack is used from a CD-ROM because changes cannot be made to a document on CD-ROM. If, however, a subscriber copied the stack from the CD-ROM to a hard drive—perhaps to increase performance—the stack could be badly damaged by someone innocently exploring in the management card. Another design option would be to delete the management card from the production version of the stack.

## Summary

The authors developed an approach to converting structured text documents to hypertext. They devised methods to restructure existing text for import to hypertext with a high degree of automation. They developed techniques to automatically create indices and hypertext links. The specific documents contained law briefs, but the methods can be used to convert a wide variety of documents such as directories, manuals, and catalogs to a hypertext format. As users gain access to hypertext, and hypermedia, over networks or on CD-ROM, it will become an accepted technology. As the acceptance grows, it will be valuable to perform automated conversions of existing print information to this flexible and powerful new medium.

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# Application of Direct Instruction Principles Using Interactive Group Technology

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## ABSTRACT

Principles of direct instruction, i.e. high levels of questioning, correct responding, immediate feedback and mastery criteria were implemented with fifteen profoundly hearing impaired students on an interactive group system called Discourse. This interactive system allowed students to respond to teacher-presented questions while receiving feedback and being monitored by the teacher. System documentation of high levels of correct responding and significant gains obtained on post-instruction measures showed the intervention's value.

## INTRODUCTION

Within any learning activity, engaged time has been shown to be critical to effective instruction and learning. Research has shown student achievement to be positively correlated with frequency of student responding and with continued monitoring of student comprehension (Rosenshine, 1983 & 1986). Yet in most classrooms, the active participation of any one student may be seriously limited. An extreme example of this limitation occurs in classrooms with hearing impaired students for whom inherent communication problems even further limit the opportunity for engaged learning time.

During teacher questioning in a normal classroom, the response given verbally by one student is heard and processed by all other students. However, the barrier created by a hearing impairment inhibits the information that is acquired indirectly from the group.

The problem of increasing engaged time was addressed by the study reported here. The goal was the creation of a learning environment that would provide increased opportunities for hearing impaired students to be directly engaged in instructional interactions. In order to accomplish this goal, the researchers focused on adapting two approaches to instruction that have consistently demonstrated positive learning effects: direct instruction techniques and an interactive communication system called Discourse. The materials were designed to embody the principles of direct instruction in an effort to create a highly effective learning environment. Learning programs which embody these techniques have consistently demonstrated increased student participation and achievement (Rosenshine, 1983; Gersten, et. al, 1987). The goals of direct instruction are accomplished by ensuring that:

1) there is a high level of a student responding;

2) there is a high level of correct responding;

3) students are given immediate feedback for responses

4) students are given end-of-session feedback on any tests or quizzes they take;

5) mastery learning is incorporated, ensuring that the class does not proceed until a criterion level of mastery is reached on the current topic; and

6) multi-media approaches or multiple representations of the content are presented whenever possible.

The findings from effective instruction research seem to clearly indicate that these strategies work. Yet how well are they implemented in the classroom? Both Gersten and Rosenshine cited studies of successful application of effective teaching strategies which were implemented after teachers had been well trained. However, there were problems in implementing these ideal strategies.

The area of teacher guided practice is a critical one in effective instruction, because it is here that important teacher initiated active learning occurs. Frequent questioning and high levels of student responding with feedback may be important. Yet strategies which allow more than a single student at a time to respond are not always practical or effective. Self-paced student seatwork is a method that allows all students the opportunity to practice and demonstrate competency, but feedback is not received until later or the next day and success is generally not controlled for during the practice time. Some programs (and some commercial materials) have utilized choral responding. Others report use of students responding on chalkboards or paper while the teacher moves around to check responses (Rosenshine, 1983). Yet while these are valid attempts at increasing student response rates, they may be difficult to implement and maintain.

In one study, it was found that "immediate correction of student errors and maintaining high student success rates" appeared to be two elements critical to student learning (Gersten, et.al., 1987). However these features were found to be difficult ones for teachers to learn to effectively implement.

The research being presented here reports on a group interaction system which is capable of fulfilling the tenets of effective instruction by enabling all students to freely respond, to receive feedback and for the teacher to be cognizant of current levels of mastery.

Of primary emphasis in the materials design was the inclusion of high levels of questioning and the establishment of criteria for mastery at each step of the instruction.

The components of effective instruction such as high rates of correct student responding, immediate feedback, step-by-step learning, mastery at each step, and many opportunities for practice can be implemented by the Discourse system easily and efficiently during typical group instruction. Discourse is a classroom system involving a single IBM computer and a classroom set of individual student keyboards with digital readout screens called Study Coms. The teacher operates the computer, using it to display questions on a large public display screen, run audio-visual equipment, and preprogram answers to questions. All student responses are entered into their Studycoms and displayed on the teachers monitor. The responses can be single letter or word to several sentences in length. If correct answers are entered into the system in advance, the students receive immediate feedback in the form of a flashing light or a beep, and the teachers screen records number and percentage of students correct on that question. Responses and class or individual records can be printed out at the conclusion of the lesson.

If during a given lesson, the teacher asks 40 questions, all students can answer all 40 and receive feedback if correct. Because the teacher knows how many students are correct, he or she can proceed forward to new material, back for review or remain on the current step for more practice. The teacher can know exactly what percentage of students are responding correctly at all times, move through the lesson accordingly, and pinpoint those who will need special attention. Mastery criteria can be set by the teacher and followed throughout the lesson.

Preparation for the study focused on the development of instructional materials which would be presented using the Discourse System. The implementation of the materials on Discourse ensured that all students could respond to every question, could receive feedback for every response, and that the teacher could monitor competency at each check point.

The target content area, mathematical rounding and estimation, is one which historically has been found to be difficult for hearing impaired learners.

The concept of "about", central to acquiring a conceptual understanding of estimation, is a particularly difficult language concept for hearing impaired and other language delayed students to grasp.

The overall goals of the study were:
1) to determine if materials could be developed in the area of estimation skills that reflect the goals of direct instruction, and
2) to determine if these materials could effectively be implemented using Discourse to teach children with language delays due to hearing impairment.

The following research questions were specifically investigated while addressing the goals of the study:

1) Will instructional materials developed under the principles of direct instruction, combined with implementation on the Discourse system, create an environment where students will have a high (90%) level of responding?
2) Will the instructional materials combined with implementation on the Discourse system, create an environment where students will have a high (80%) rate of answering questions correctly?
3) Will these instructional materials increase students' rate of responding (compared to regular classroom instruction)?
4) Will these instructional materials improve students' ability to solve rounding and/or estimation problems?

## METHOD

### Materials development

For the current study, instructional materials were developed to reflect the principles of direct instruction. To this end the materials incorporated high levels of questioning, immediate feedback, mastery learning, and use of multi-media. The materials set the style of the instruction. The Discourse System provided the technology to implement high levels of responding and feedback.

A set of ten instructional objectives were written in the areas of rounding and estimation skills. These included rounding with and without a number line, rounding single and two digit numbers up to 90, the concept of estimation, and estimating sums of two digit numbers up to 90. Each of these objectives was broken into small steps, or subsets of the objective. A sub-set was a set of like problems to solve or questions to answer, comprising one step in the process of attaining the stated learning objective.

The instruction was divided into a series of ten lessons, each focusing on one of the instructional objectives and incorporating the small steps or subobjectives. Each lesson was planned with three main components: 1) review of relevant, previously taught material, 2) group instruction on the instructional objective for the day, and 3) self-paced practice on the lesson's objective. Guidelines for effective instruction, as detailed previously, were incorporated into all lessons. Frequent teacher questioning, immediate feedback, and mastery learning were a particular focus.

The philosophy of the design determined that a minimum level of 80% mastery on each step or sub-objective would be attained before moving on to the next. A fully worked out example of the material or skill to be learned in the set was presented first, as a kind of advance organizer. Then one or two critical items were presented to the group. If 80% or more of the group were correct on the critical item(s), the teacher could move on to the next sub-objective set of items. If not, additional practice items were presented until the mastery criterion was reached.

The instructional materials informed the teacher of critical items and mastery criteria required at each step. Decision points were color highlighted, and instructions for where to move next were indicated in the materials. Instructions about which color coded key or keys to press on the Discourse monitor were also included in the teacher's materials so that someone new to Discourse or new to computers could implement the instruction with minimum prior experience.

The Discourse system not only provided feedback to the student but indicated instantly to the teacher what percentage of students were correct on a given question, with all student names and responses presented on the teacher's monitor.

The materials were designed to involve high levels of student responding. Thus, most of the material was in the form of teacher directed questions or problems for students to solve. Discourse made it possible for all students to respond to all questions, provided feedback to all students, and gave the teacher instant information on which to base decisions for the next item to present. With materials designed to incorporate effective instruction principles, the technology could make implementation easy and effective.

### Subjects and Setting

Fifteen deaf students participated in the instructional phase of this study. Students selected were those who demonstrated competence on the pre-test in areas of addition of single digits and tens, and use of number lines. In addition, the students were selected who demonstrated poor performance in rounding and estimation skills. Of the 15 subjects, six were male and nine were female. There were thirteen Caucasian and two Asian subjects. These students were in grades three through six and exhibited severe to profound, bilateral hearing impairments. All of the students required self-contained instruction for all or part of their academic day, including mathematics instruction. Standardized math results on the SRA achievement tests indicated a percentile range from the first to the seventy-seventh percentile, with a mean of 12.4%. Of the fifteen, two were also visually impaired and several exhibited identifiable learning disabilities in addition to hearing loss.

### Measures

Several measures were utilized to assess effectiveness of the instruction. All students in the study were tested on the material prior to instruction, immediately following instruction, and six weeks following instruction. The test consisted of 37 items, 19 of which assessed prerequisite skills such as addition and use of number lines. Eighteen items assessed the estimation and rounding skills which were taught during the instructional phase. The estimation/rounding items included: rounding to the nearest ten with a number line present, rounding to the nearest ten without a number line, estimating sums of two-digit numbers to the nearest ten, and estimation word problems.

During the instruction, several other kinds of data were gathered. Following each lesson, the Discourse System generated printed reports which indicated individual and collective response levels for items presented and questions asked during group instruction and individual practice. Two reports, a Detail Report and a Question Report, were produced. The Detail Report gave an item-by-item display for each student, indicating each item to which he or she responded and whether or not the response was correct. This report also produced total number of items tried and number of items correct. The Question Report provided a breakdown by question for the class as a whole, indicating the percentage of students who attempted each question, the percentage of students correct, and the percentage correct over attempts. A mean and standard deviation for the entire lesson was also calculated on this report. Both reports were produced for group and self-paced instruction.

Formal and informal observations were conducted to assess frequency and type of interactions occurring during instruction. Formal observations were recorded using an instrument developed by Craig and Collins (1970), designed to assess initiation of interaction in classrooms of hearing impaired children. The instrument uses a time-interval observation schedule (in our case, observations made every 30 seconds). At each observation point, the observer noted who was initiating interaction (teacher or student), what type of interaction occurred (instruction, demonstration, question, feedback, etc.) and what additional vehicle of presentation was utilized (media, paper-based, etc.). Interrater reliability was found to be 90%.

Informal observations were conducted to determine frequency of questioning and the time interval between items during instruction. This simply involved an observer noting the time that each new instructional item was initiated.

## RESULTS

### Test Data

Pre-instruction and post-instruction test scores were compared to measure growth on the skills of estimation and rounding. The overall mean score for the instructional group on the pretest was 25.3 out of 37 or 68% correct. The posttest mean score was 33/37 or 89% correct. Mean scores for the prerequisite skills on both the pretest and the posttest were 18 or 95% correct, indicating that students had mastered basic skills in addition and use of number lines prior to the start of instruction. In the instructional areas of rounding and estimation, mean scores on the pre-test were 7 out of 18 or 39% while mean post-test scores were 14.9 out of 18 or 83%.

A retention test was administered six weeks following the completion of the study which yielded mean results of 91.7% correct overall; 86% correct on the estimation/rounding sections, indicating that the students had retained the concepts learned during instruction.

### Observational data

Observation and Discourse reports provided information on frequency and correctness of student responding. During the ten lessons, an average of 32.4 questions were asked during the group instruction portion of class sessions, ranging from 14 to 52 questions per session. Time spent on any given item ranged from 10 to 225 seconds (mean of 53.6 seconds). The design of the materials was intended to foster frequent questioning. Since all students had the opportunity to respond to all questions, and since the teacher had an immediate display of individual responses and percentages of responses correct, she could judge immediately whether or not criteria had been reached and move quickly to the next appropriate item. next set). Time was not spent sampling responses from students one at a time, as is the procedure normally in group-based instruction.

Reports produced by the Discourse System were analyzed in two ways: 1) by question and 2) by student. The overall percentages by question were derived by determining the percentage of responses out of the total number of opportunities to respond. For example, if 30 questions were presented during a single class session and there were 15 students present, there would have been 15 X 30 or 450 total opportunities to respond. If 400 of those opportunities resulted in some response from a student, the response percentage would be 89%. In the current investigation there was a 97% response rate across all ten lessons during group instruction. 94.6% of those responses were correct.

During independent practice, students entered answers to worksheet problems on their Studycoms. These were also scored and recorded by the Discourse system. An average of 16.6 problems per session, ranging from 13 to 20, were given on practice worksheets. In this segment of instruction, student response rates averaged 94% with a rate of 94.4% correct.

Given the 97% response rate, one can assume that almost all students responded to every question. The teacher was aware, however, based on information on her computer screen, of which students were not responding and which were responding incorrectly. No student attempted fewer than 87% of the questions presented, and the lowest percent of correct responding was 75%. The average student attempted 97.9% of the questions asked, 91.2% of which were correct. Though some students had more difficulty than others, it is important to note that all students remained actively involved. Only two students fell below the mastery criteria of 80% and these were at 75% and 76% respectively. The Discourse reports were valuable to the teacher in pinpointing the extent to which students were on task and at what level of mastery each was functioning.

The Craig/Collins (1970) observation instrument, designed to measure communication in classes of hearing impaired children, was used to analyze classroom interaction. The primary intent of the instrument is to determine who initiates communication in an exchange between teacher and students.

Observations using this instrument revealed overall results similar to those obtained previously by Craig and Collins (1970). Craig and Collins found that most communication during group instruction was teacher initiated. In fact, teacher initiated communication in their research accounted for 80% of the communication behavior during instruction at the primary level and 94% at the intermediate level. Student initiated communication was 3% and 4% respectively (Craig & Collins, 1970). In Craig and Collins' system, the category of teacher initiated communication includes the actual communication from the teacher, the student response to that communication and the feedback given. In the present study, teacher initiated communication accounted for 79.9% of the teacher/student interactions as compared to 4.8% student initiated communication. This compares favorably to Craig and Collins data.

When teacher initiated interactions are analyzed further, however, significant differences appear. Craig and Collins found that, during teacher initiated interactions in the classroom, 75% was actual teacher communication and 25% was student response. In contrast to these results, of the 79.9% teacher initiated communication in this research, 48% of interaction time involved teacher communication, 30% involved student responding, and 22% was feedback to students. In other words, true dialogue was occurring in which one-half of the time the teacher was directing a question, and the other half involved students giving responses and receiving feedback. Student responding was almost exclusively tied into the Discourse system. Since all students could respond at once, the 30% of the instructional time that involved active student responding is magnified by the fact that all students were actively participating, not one at a time, as was the case in the data presented by Craig and Collins.

## CONCLUSIONS

The goals of this study were 1) to develop materials which reflected the principles of direct instruction and 2) to implement the materials by means of an interactive group system. The materials were designed to produce high levels of teacher questioning, to elicit high levels of student responding and to incorporate immediate feedback and mastery learning.

The goal of 90% level of responding was met. Students attempted an average of 97% of items presented during group instruction and 94% during inidvidual practice. The goal of 80% correct response rate was met and surpassed during group and individual instruction. Students' ability to solve estimation and rounding problems improved dramatically and was retained as evidenced by pretest, posttest and retention test scores.

During instruction, each student received immediate, individual, corrective feedback on each response, and instruction proceeded based on mastery levels of the students as a group. Discourse provided both students and the teacher with important information on progress and allowed a more efficient utilization of time. The lesson design proved workable and relatively easy to use by a teacher with no prior Discourse experience.

The data regarding teacher/student interaction support the use of a group-interaction system such as Discourse for increasing the active participation of students. With Discourse, one-half of the teacher-initated, active instructional time in which communication was occurring was student response and feedback, double the time found in previous studies. This figure is more impressive when one considers that every opportunity for students to respond involved all students being able to respond and all who responded received feedback. Given what we know about the effectiveness of engaged time and learning, these results demonstrate that carefully designed materials and effective use of technology can implement effectively these well researched qualities of effective instruction.

Active student learning, feedback, and mastery are well known tenets of good teaching. Implementation has not proven to be easy in a group setting, however. Applying computer technology in this setting, as support to facilitate effective teaching and as the vehicle for maximizing the communication environment is apparently an effective alternative for applying the power of the computer to instruction. Further study is planned to implement the materials with a group of learning disabled students and to compile the materials into a package usable by teachers to teach estimation and rounding with and without the Discourse System.

The components of instruction which have been shown to be effective for learning can be implemented effectively with carefully designed materials and can be facilitated by the use of innovative technology support. While group-based technology is currently not available in most schools, there is evidence that this type of technology may become an important alternative for instruction.

Use of technology to implement active learning by all students, to give feedback to all students and to enable the teacher to continuously monitor performance of the class and adjust instruction is a potentially powerful application of computer technology to effective instruction.

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# COMPUTER USE IN 550 UNDERGRADUATE NURSING PROGRAMS

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## ABSTRACT

How are microcomputers being used in nursing education programs? To what extent do faculty perceive selected computer implementation activities to be true? The responses of 550 program administrators representing 49 states provide answers to these questions. This paper summarizes selected items from a national survey conducted in 1987 and repeated in 1988 by the Continuing Nursing Education in Computer Technology project, A Nursing Special Project grant (D10NU24198-05) administered by the Southern Regional Education Board.

## METHOD

In August 1988, a 55-item questionnaire was mailed to 1,311 institutions offering nursing education in the United States to determine the extent of computer use at the undergraduate level. (The mailing was restricted to institutions that provide programs of study leading to either an associate or baccalaureate degree.) The survey was designed to elicit information about the current use of microcomputers in the undergraduate program and faculty perceptions of the extent to which computer implementation activities were underway.

## RESULTS

The 42 percent return rate included 281 four-year and 268 two-year institutions. Collectively, the returns represented 281 baccalaureate and 304 associate degree programs. A summary of the aggregate compilations follows.

**Availability**. Microcomputers were available for student use at a majority of the institutions. The nurse educators (72 percent) reported that microcomputers were available for instruction within the nursing education unit.

**Access**. Faculty, students, administrators, and staff in the nursing education programs had access to the microcomputers within the nursing education facility. The percentages reported for staff access were consistent with the 1987 results; those for faculty, administrators, and nursing students increased slightly (Table 1).

**Plans (purchase)**. Thirty-two percent of the nurse educators reported plans to expand the number of microcomputers within the year. Of the 143 programs without microcomputers, 5 percent had plans for initial purchases. (In contrast, 32 percent of 184 programs indicated plans for initial purchases and 39 percent of 363 programs reported plans to expand existing resources in 1987.)

**Uses**. The percentage of nursing programs using microcomputers for pre-nursing and nursing instruction increased in 1988 (Table 2). Drill and practice, tutorials, simulations, testing, and word processing were the top five (of 11 major types) learning activities at a majority of the 385 institutions where students had access to microcomputers in nursing courses.

**Table 1**

**Microcomputer Access**

| | 1988<br>N=549 | 1987<br>547 |
|---|---|---|
| Faculty | 87% | 82% |
| Administrators | 77 | 76 |
| Staff (nursing) | 78 | 78 |
| Nursing students | 66 | 43 |

Note. Percentage of "yes" responses.

**Table 2**

**Computer Use**

| | 1988<br>N=549 | 1987<br>547 |
|---|---|---|
| Pre-nursing | 53% | 47% |
| Nursing | | |
| Microcomputer | 70 | 64 |
| Mainframe | 10 | 10 |

Note. Percentage of "yes" responses.

Of 24 possible nursing content areas taught in whole or part with microcomputers, the top 5 were calculations, clinical case studies, adult nursing, basic mathematics, nursing process (Table 3). These same content areas were identified in the 1987 study, though the percentage was slightly higher in 1988, with one exception (nursing process). The 1988 percentages were also slightly higher for pediatric nursing, mental health nursing, pharmacology, and maternity nursing.

A majority (76 percent) of the nurse educators indicated that staff nurses (in the clinical agencies where the undergraduate nursing students had clinical learning experiences) used computers on a regular basis, e.g., nursing notes, care plans, lab reports. Only 44 percent indicated that undergraduate students used computers in the agencies during their clinical learning experience. Less that 50 percent of the total student enrollment was expected to use computers in clinical settings.

**Table 3**

**Nursing-related Content Areas**

| | 1988<br>N=385 | 1987<br>349 |
|---|---|---|
| Calculations | 66% | 58% |
| Clinical case studies | 52 | 47 |
| Adult nursing | 58 | 54 |
| Clinical decision-making | 44 | 54 |
| Basic mathematics | 50 | 46 |
| Nursing process | 47 | 57 |
| Pediatric nursing | 42 | 40 |
| Pharmacology | 36 | 11 |
| Maternity nursing | 44 | 31 |
| Computer literacy | 31 | 23 |
| Mental health nursing | 40 | 38 |
| Clinical topics | 34 | 39 |
| Literature searches | 24 | 23 |
| Psychomotor skills | 17 | 9 |
| Research | 27 | 19 |
| Nutrition | 24 | 21 |
| Medical terminology | 18 | 25 |
| Statistics | 19 | 13 |
| Nursing leadership | 9 | 11 |
| Community health nursing | 8 | 9 |
| Nursing management | 9 | 18 |
| Anatomy/Physiology | 9 | 8 |
| Public health nursing | 3 | 4 |
| Pathology | 3 | 3 |

Note. Percentage of "yes" responses.

The top five non-instructional uses were word processing, student records, calculation of grades, test scoring, and test construction. Comparisons of 1988 and 1987 data revealed slight increases in most categories (Table 4).

**Perceptions.** Key activities, essential to the implementation of computer-supported curriculum, include documentation of need, identification of resources, and allocation of capital resources. Perceptions of the extent to which 29 key activities were true for the programs were rated on a scale of 0 (not at all true) to 6 (maximum extent). The extent to which most perceptions were true in the 1988 study was in the "low" or "moderate" range (1 to 3).

Six activities were perceived to be "not at all true" by a majority of the nurse educators. These same activities were identified at a majority of the programs in the 1987 study (Table 5).

**Table 4**

**Non-instructional Uses**

| | 1988<br>N=509 | 1987<br>515 |
|---|---|---|
| Word processing | 96% | 94% |
| Student records | 74 | 93 |
| Test construction | 60 | 62 |
| Calculation (grades) | 53 | 52 |
| Test scoring/grading | 45 | 47 |
| Reports | 39 | 41 |
| Spreadsheets | 39 | 39 |
| Graphics | 34 | 32 |
| Recruitment data | 32 | 31 |
| Data analysis | 24 | 23 |
| Transparencies | 26 | 23 |
| Data management | 25 | 28 |
| Authoring programs | 24 | 24 |
| Forecasting | 12 | 11 |

_Note_. Percentage of "yes" responses.

**Table 5**

**Implementation Activities**
(Not at All True)

| | 1988<br>N=549 | 1987<br>549 |
|---|---|---|
| Faculty incentives | 57% | 61% |
| Software development | 57 | 57 |
| Evaluation | | |
| Cost effectiveness | 61 | 63 |
| Cost benefits | 52 | 56 |
| Expanded use | 52 | 55 |
| Extended use | 66 | 69 |

A factor analysis of the 29 statements in 1987 reduced the dimensions of computer implementation activities to four factors: resources, faculty involvement, planning, and evaluation. Of the four factors, scores for evaluation indicated the least activity. Although computer use in undergraduate nursing education programs increased, programs were more involved with computer implementation activities related to resources and planning than those concerned with faculty involvement and evaluation (Mikan, 1989).

**Concerns**. The constraints of budgets, a lack of commitment, negative attitudes, lack of skills, and few incentives were among the obstacles to computer use cited by program administrators in the 1988 survey. These concerns were reported in 1985 and 1987 surveys.

Although the potential of the microcomputer to augment instruction in nursing education has not been realized, the slight increase in computer usage noted in the 1988 study indicates progress in some undergraduate nursing programs. Continuing education activities at national, regional, and local levels will help nurse educators become more proficient in their use of technology to achieve educational and personal goals.

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# Student Controlled Learning in a Medical Biochemistry Course

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## ABSTRACT

The preclinical medical curriculum is heavily loaded with lecture presentations, and is largely exam driven. Independent, self-directed learning is nevertheless attainable with the aid of microcomputers. We have begun to develop interactive student-controlled software to achieve this on the scale of a whole course. Evaluation of efforts in this area are best performed using an ethnographic approach.

## INTRODUCTION

The typical medical school curriculum is divided into two distinct parts: the basic sciences, which usually comprise the first three semesters, and the clinical training , which takes the remaining two and one half years. The basic science curriculum has a number of well-recognized problems. Basic science courses are usually taught by faculty holding Ph.D. degrees; some of these faculty have little interest or motivation to make the basic science courses relevant to the clinical sciences (Rothstein, 1987). Medical students, on the other hand, are more interested in the clinical sciences, and may tend to regard the basic sciences as a ritual they must endure to become physicians. In addition, the explosion of scientific knowledge has resulted in a massive amount of material to be digested by the medical student in a very short time; there is often not time to really understand the scientific principles on which clinical medicine is based. Performance in the basic science courses is generally evaluated with multiple-choice examinations, and at the end of the first two years, most medical students take a standardized multiple choice test given by the National Board of Medical Examiners (NBME). It becomes easy for students to fall into a trap of "memorizing facts enough to pass the exam;" this cycle is perpetuated right up until the moment when Part I of the National Board examination is completed, whereupon the medical student feels free to "forget" the basic science knowledge.

While these problems are not peculiar to Biochemistry, the study of Biochemistry is seen by students to be the "least relevant" and "most difficult" of the basic sciences (Chandrasekharan, 1988). Further, Biochemistry is usually taught in the first semester of the first year, a stressful time when the student is still adapting to the demands of medical school.

In an attempt to address some of these problems, the Association of American Medical Colleges (AAMC) published in 1984, "Physicians for the 21st Century: Report of the Panel on the General Professional Education of the Physician and College Preparation for Medicine" (the GPEP Report). The report made the following major recommendations for educational reform in the medical schools:

1. The amount of factual information that students are expected to memorize must be limited.

2. Medical students should be encouraged to learn independently, and opportunities should be provided to turn

medical students into life-long, self-directed learners.

3. Medical faculties should consider major reductions in passive learning; lecture time should be reduced. Students should be required to be active, independent learners and problem solvers.

4. Medical schools should lead in the application of information science and computer technology to educational purposes.

All of these recommendations, with the exception of the fourth, were put forth some fifty years earlier in a similar report by Rappley. Despite continued lip service to the GPEP goals by medical school administrators, true educational reform in medical schools has not been forthcoming, and the basic science curriculum remains essentially exam driven.

## REVIEW OF THE LITERATURE

Even before the 1984 GPEP report, medical school faculty had introduced computer-assisted instruction (CAI) programs as a vehicle for promoting self-directed, active learning situations. In the mid-70's, a few pioneering medical schools used mini-computers to produce clinical simulations, but the use of CAI did not spread to medical education in general. In a recent article summarizing CAI development in medical schools over the last two decades, Piemme listed several impediments to widespread CAI development in the mid-70's: limitations in transferability, the large number of hours required to develop a program, the lack of information about what is available, and the oftentimes doubtful quality of the software.

Piemme cites 1984 as the landmark year of CAI development and use in medical schools. For the first time, cost-effective microcomputers were available; more faculty became computer-literate; and new authoring systems appeared. In addition, the NBME announced plans to implement a computer-based examination consisting of simulated clinical problems by 1991 as a replacement for the pen-and-paper Part III Boards. And, of course, the GPEP report was published.

Piemme's review of the literature on CAI in medicine produced a number of references to studies evaluating the effectiveness of clinical simulations; but he lists few references to CAI effectiveness in the basic sciences. It appears that most CAI development in medicine has occurred in the clinical sciences.

## RESEARCH ON CAI DEVELOPMENT AND USE IN BIOCHEMISTRY

A literature search on CAI in the basic sciences produced two categories of publications: (1) the "we've-produced-this-great-program-and-the-students-like-it" type of article, wherein the software is described (usually by the author) and anecdotal evidence is offered of its effectiveness; and (2) the research paper, which attempts to compare the effectiveness of CAI with traditional learning methods, such as lectures or textbook study. The first category of articles will not be dealt with here, except to note that in all of the articles identified, the CAI covered only one very small section of a course; no one has attempted to study CAI effectiveness in an entire course.

Three articles (Stevens, 1987; Escanero, 1987; Simpson, 1987) in the second category were identified in Biochemistry, although similar studies have appeared in other basic science areas. The comparison articles suffer an "invalid implicit assumption" which was described by Hagler and Knowlton in 1987. Haglor and Knowlton assert that the endless CAI comparison "research" studies make the fundamental error of confusing the media and the message. Specifically, the message contains the symbols necessary to organize knowledge; the media is the physical device used to transmit the symbols. The comparison of CAI with traditional methods, such as a lecture or textbook study, is a comparison of messages rather than the media. The comparison may actually be one of more instruction with less instruction; or bad instruction with good instruction; or neatly packaged, organized instruction with helter-skelter, unorganized instruction. But the medium in all of this is still neutral. In fact, Haglor and Knowlton assert that if the instructional method and content were held exactly the same, with only the media varied, there would be no reason to expect significant differences in the quality of the learning which took place. Specifically:

> "There are a multiple of studies documenting the ability of a group or person to produce superior learning by using CBI, but few studies clearly

> documenting that superior learning *was due to characteristics unique to CBI.*" (emphasis added)

Previous research relating to CAI use in the basic sciences has not addressed the use of CAI in an entire course, nor has anyone documented how CAI might meet the GPEP goals described above.

## DESCRIPTION OF THE SOFTWARE

We have developed a prototype for a series of programs in Medical Biochemistry which we believe will address the GPEP goals as well as provide a research tool for answering important questions about CAI use in basic science education. Software has been produced in two subject areas (Gas Transport and Peptide Hormones -- 10% of the course), and was field-tested in the fall semester of 1988. Programs covering all subject areas will be completed by the Fall of 1991.

The software is written for the Macintosh computer using a combination of HyperCard and Pascal. Although the software has been carefully designed to represent a coherent whole and to link many types of related information, it can best be described in three parts:

1. The course outline (core of the course). The course outline is the entire material content of the course in detailed outline format. Related to each point are relevant graphical illustrations (with animation where appropriate), multiple choice questions, short answer questions, cases and clinical correlations, tables, graphs, references, and behavioral objectives.

2. The examination questions (self-evaluation). The examination questions are multiple choice questions that were asked on past examinations. Questions are annotated with explanations of why each choice is correct or incorrect.

3. Biochemistry simulations (internalization). Biochemistry simulations provide the student with an opportunity to obtain a deeper understanding of Biochemistry.

Each of these three parts will be divided into fifteen major subject areas. The student may enter the software by subject area or by type of activity (primary learning, self-evaluation, review) or by a combination of the two (*e.g.* review of amino acid metabolism). Each subject area has an overview of all the major points in that topic. An index is available as a guide to more detailed information in any topic, and a "find" button is available within topics to take the student to any area of interest.

## STUDENT-CONTROLLED LEARNING

With advances in hardware and authoring tools, the term "CAI" is becoming more and more of a misdesignation. Too often, "CAI" is associated with electronic page turners, drill and practice, or "programmed" learning. The software described above is, in fact, quite the opposite of inflexible, algorithm-controlled learning; rather, it is learning controlled by the *student*. The student is in control of the sequence of learning and is able, in some cases, to manipulate the content as well (Laurillard, 1987). We therefore refer to this approach as "SCL" (Student-Controlled Learning).

Besides offering the student complete control over the learning environment, this software has a number of other attributes which have not been implemented in other Biochemistry programs. It is truly interactive, where interactivity is defined as a system which "provides for interruptibility, graceful degradation, limited lookahead, and gives the impression of having an infinite database" (Berganon, 1988). The information is layered; many different views of the same concepts are available, and it is dynamically linked, so it is possible to relate many pieces of fragmented information. Students are guided through the material in a manner which is appropriate to the content and the goals of the program, but they always have the opportunity to explore freely any of the pathways of linkages in the program (Baggott, 1989).

## EVALUATION

When goals such as encouraging independent, life-long, self-directed learning and problem solving are pursued, traditional positivistic measurement instruments applied within a short time frame appear less attractive than an ethnographic approach. A "thick description" of the students' reaction to the software must be compiled based on student-kept logs, observation notes, course evaluation survey, interview notes, and follow-up surveys. Issues related to the original goals for the software may be addressed using the information in the thick description. Pertinent questions related to the goals are described below.

### Reduction in Study Time/Lecture Time

Was the software used as a replacement or a supplement for lectures? What percentage of the study time was the software used? What percentage of lecture time?

### Self-Directed Learning

Did students adjust to the opportunity to skip lectures and direct their own learning? Was there a trend over time in the proportion of lecture/computer time? Did students perceive themselves as self-directed learners? Would they prefer the same method to be used in other courses? Did the students work alone or form informal groups for learning? Did those in groups feel they learned faster than they would have alone?

### Clinical Relevance

Did the students use the cases and clinical correlations? Did they perceive the course as being "clinically relevant"?

### Internalization of Concepts vs. Memorization of Facts

Did the students use the Biochemistry simulations? Did the students feel that the simulations helped them obtain a deep understanding of Biochemistry as opposed to memorizing facts?

### Information Access

Did the students use the software in a sequential or non-sequential manner? Did they return to the same information to "look something up"? Did they feel they would use the software later for other purposes, such as studying for National Boards? Did they feel that access to this type of information would be helpful in the rest of their medical school career?

## Conclusion

Current indications are that, GPEP not withstanding, the basic medical science curriculum will continue to be driven by examinations well into the future. Within this framework, however, the goals expressed by the GPEP and other reports remain both desirable and important. We believe that SCL is the most likely means of achieving them, and if the approaches used in this project prove effective, recommendations will be made for further software development in biochemistry and other basic sciences.

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# DIFFERENCES IN ATTITUDE TOWARD COMPUTER-BASED VIDEO INSTRUCTION AND LEARNER CONTROL CHOICES MADE BY BACCALAUREATE NURSING STUDENTS OF SENSING AND INTUITIVE PSYCHOLOGICAL TYPE

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## ABSTRACT

The presentation will report on a study of (1) the relationship between subjects' psychological type (MBTI) and learner control choices made in a computer-based video instruction (CBVI) program, and (2) subjects' attitudes toward the program. The treatment CBVI module on spiritual care of the patient is programmed on IBM's InfoWindow Presentation System (IWPS) using an IBM PS/2 Model 70 microcomputer. The program interfaces with a Pioneer LD-V6200A LaserVision LaserDisc player. Data were not analyzed until after the PROCEEDINGS deadline; therefore, only fictitious data are published in the PROCEEDINGS. Study data handouts will be available at the formal paper presentation.

## INTRODUCTION

The body of nursing literature on computer assisted instruction (CAI) has been steadily growing since the 1960s (Bitzer, 1966; Kirchhoff, 1979; Conklin, 1983; Reynolds, 1986; Sizemore, 1987). Conclusions from CAI studies in nursing education indicate that learning does take place, in a shorter period of time, and that students develop positive attitudes toward CAI (Belfry, 1988). The recent addition of video to CAI technology, computer-based video instruction (CBVI), has demonstrated even greater potential for enhancing the learning process (Fishman, 1984; Longcrier, 1985; Rickelman, 1988; Skaggs, 1985). Four CBVI studies from other fields, but using learner control options, have demonstrated similar outcomes to those cited from nursing (Laurillard, 1984; Gay, 1986; Hannafin, 1986; Ho, 1986; Milheim, 1988). However, the reported CBVI studies have not investigated differences related to learners' psychological type and use of learner control options. Studies show psychological type may have some influence on computer-based instruction experiences (Hoffman, 1981; Kern, 1988).

Therefore, this study examines whether differences exist among baccalaureate nursing student subjects of sensing (S) and intuitive (N) psychological type who use a CBVI program with learner control options. Specifically, do subjects with different psychological types who use the CBVI program (a) make different choices in the program when the opportunity to view more information or see selected program segments again is within their control, and (b) exhibit different attitudes toward the program? This study may contribute information about important variables that relate to designing CBVI programs for baccalaureate nursing students.

Two studies report on psychological type and CAI with learner control options (Hoffman, 1981; Hoffman, 1982). Studies related to subjects' psychological type and CBVI have not been reported. Psychological type may prove to be a significant variable to consider when designing CBVI programs. For example, nursing students of sensing psychological type may prefer certain types of choices in CBVI programs; and, nursing students of intuitive psychological type may prefer different types of choices. Further, these students may show differing attitudes toward the CBVI program, according to the two psychological types.

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Thus, this study is important to help describe one of the variables, that is, psychological type, that may relate to CBVI use in nursing education.

### Theoretical Framework

This study is based on two theoretical frameworks: (a) Gagne's conditions of learning (Gagne, 1985,) and (b) Jung's psychological type as operationalized by using the Myers-Briggs Type Indicator (Myers, 1980). A model showing the relationship between the theories of Gagne and Jung is depicted in Figure 1. An expansion from Figure 1 of the interaction between the CBVI intervention and the learner is depicted in Figure 2.

Gagne's constructs about the ways in which people receive and then use information to achieve learning objectives are used to support programming methodology; Gagne's constructs about attitude toward learning are also used. Jung's constructs about individual differences in personality (Campbell, 1971) are used to study individual preferences about learning.

Jung's psychological types are concerned with the conscious aspects of personality. These determine how people take in information and how they decide what to do about their perceptions (McCaulley, 1976, p. 729). For the purposes of this study, Kelly's Adjective Rating Scale (ARS) is used to observe learner attitudes toward the CBVI program (Kelly, 1976). The sensing (S) and intuitive (N) psychological types, the ways of perceiving, are used because of their relation to learning theory and because of research findings.

Methods of perceiving are significant in Gagne's conditions of learning; in particular, selective perception is important to the information processing model (Gagne, 1985, p. 71). Two studies showed that the S and N psychological types were significant for CAI. Hoffman, Waters, and Berry found military subjects of S psychological type tended to complete the CAI program sooner than Ns; no other types showed such a difference (Hoffman, 1981). Kern and Matta's study with learner control and CAI found S college students had better success than N students (Kern, 1988). It is likely, then, that the perception processes may be important for CBVI.

### Research Questions

RQ(1): Is there a difference between subjects' psychological type (sensing, S and intuitive, N) and the learner control choices made in the computer-based video instruction program to view more information, or see selected program segments again?

RQ(2): Is there a difference between subjects' psychological type (sensing, S and intuitive, N) and their total scores and factor scores on Kelly's Adjective Rating Scale for the computer-based video instruction program with learner control choices?

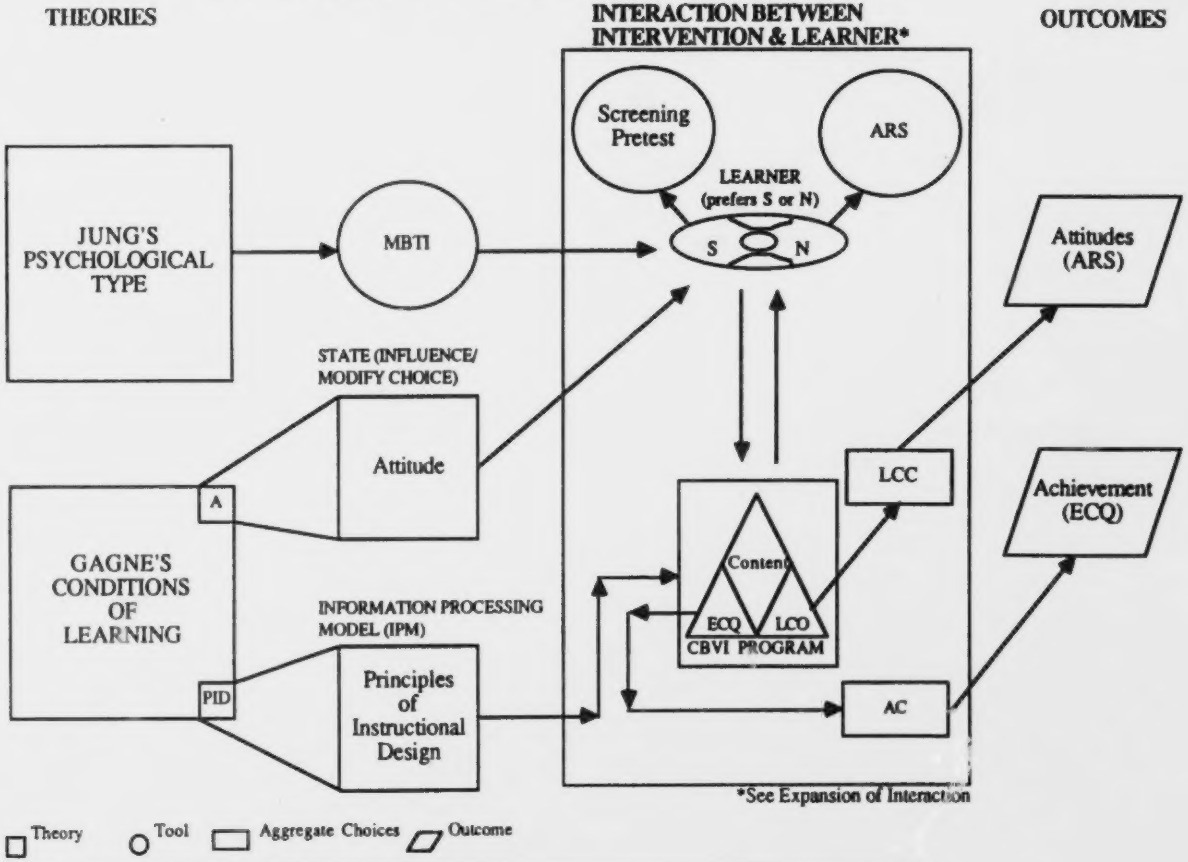
### Research Design

The investigation uses an exploratory descriptive design. The treatment CBVI module on spiritual care is programmed for IBM's InfoWindow and run on an IBM PS/2 Model 70 microcomputer. The program interfaces with a Pioneer LD-V6200A laser videodisc player. (IBM-XT or AT microcomputers will also run this program.) IBM's InfoWindow Presentation System (IWPS) authoring software, Level 050(A), is used. Major strengths of the IWPS work station include (a) graphic overlay and control for both touch-screen and voice synthesis functions on an intelligent terminal, (b) random access to videodisc segments, and (c) the ability to address Level 3 interactivity (Lambert, 1987, p. 99; Hannafin, 1988, pp. 357-358). The text screens for the program were input with WordStar 5.5 word processing software, and imported to IWPS via the disk operating system (PC-DOS, Version 4.01). Graphics screens for the program were input with Mouse Systems PC Paint Plus software, and also imported.

Nursing process content for the CBVI treatment module is spiritual care of clients (patients). The spiritual dimension of health should be considered in holistic care (Potter, 1985, p. 403), and is therefore considered valid content for nursing students. Nursing diagnoses related to spiritual care are included under the classification of Spiritual Distress, which falls under the functional health pattern of Value-Belief (Gordon, 1985).

The treatment videotape instruction cassette for the CBVI module is made by editing portions of five videotapes used successfully for several years throughout the United States, with spiritual care workshops for nurses and nursing students

Figure 1. Hassett's Computer-Based Video Instruction Model Using Jung's Psychological Type (Sensing and Intuitive) and Gagné's Conditions of Learning


THEORIES
INTERACTION BETWEEN INTERVENTION & LEARNER*
OUTCOMES
Screening Pretest
ARS
LEARNER (prefers S or N)
S
N
JUNG'S PSYCHOLOGICAL TYPE
MBTI
Attitudes (ARS)
STATE (INFLUENCE/ MODIFY CHOICE)
Attitude
LCC
A
Achievement (ECQ)
GAGNE'S CONDITIONS OF LEARNING
Content
ECQ
LCO
CBVI PROGRAM
INFORMATION PROCESSING MODEL (IPM)
PID
Principles of Instructional Design
AC
*See Expansion of Interaction
Theory
Tool
Aggregate Choices
Outcome

Legend:
MBTI = Myers-Briggs Type Indicator
S = Sensing N = Intuitive
CBVI = Computer-Based Video Instruction
ARS = Adjective Rating Scale
ECQ = Embedded Content Questions
LCO = Learner Control Options
LCC = Learner Control Choices
AC = Achievement Choices

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McMRH1/Model-1

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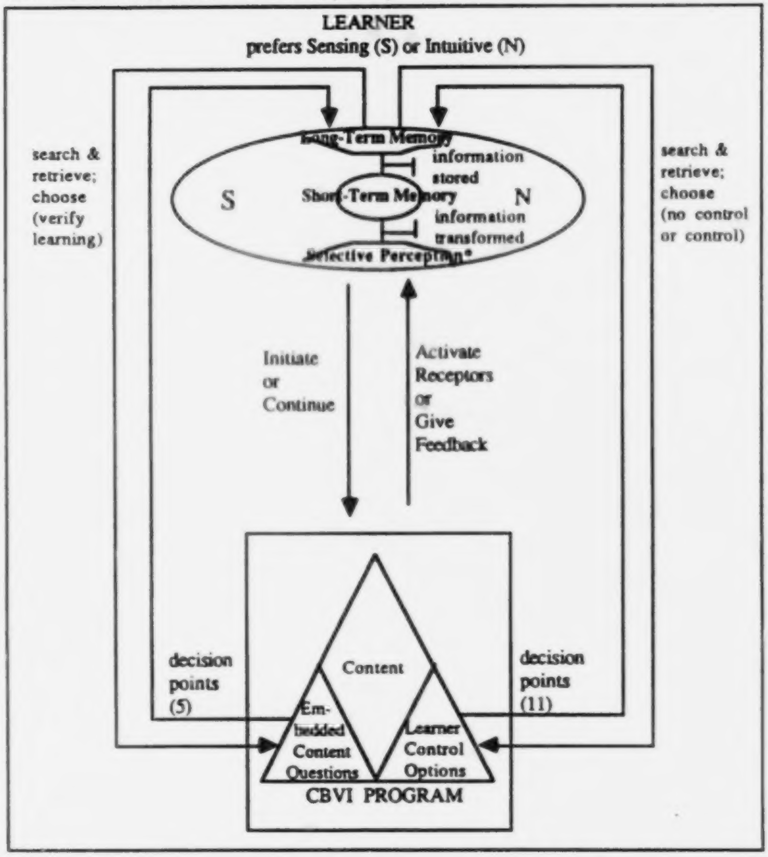
Figure 2. **Expansion of Interaction, Hassett's Computer-Based Video Instruction Model Using Jung's Psychological Type (Sensing and Intuitive) and Gagné's Conditions of Learning**

**INTERACTION BETWEEN INTERVENTION & LEARNER (detail)**


LEARNER
prefers Sensing (S) or Intuitive (N)
search & retrieve; choose (verify learning)
Long-Term Memory
information stored
S
Short-Term Memory
N
information transformed
Selective Perception*
search & retrieve; choose (no control or control)
Initiate or Continue
Activate Receptors or Give Feedback
decision points (5)
Content
decision points (11)
Em-bedded Content Questions
Learner Control Options
CBVI PROGRAM

| Legend: CBVI = Computer-Based Video Instruction | Embedded Content Questions = ECQ<br>Learner Control Options = LCO |
|---|---|

References: Manual: A guide to the development and use of the Myers-Briggs Type Indicator by Isabel Briggs Myers and Mary H. McCaulley, 1985, 2nd ed., Palo Alto: Consulting Psychologists Press.
Principles of instructional design by Robert M. Gagné, Leslie J. Briggs and Walter W. Wager, 1988, 3rd ed., New York: Holt Rinehart & Winston.

*Note: Selective Perception (SP) influenced by Psychological Type:
Sensing (S) way of perceiving means directly aware through 5 senses;
Intuitive (N) way of perceiving means indirectly aware through unconscious.

Rev2.1 05/04/89
McMRH1/Model-1.1

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(Heather, 1981). The edited videotape is sent for mastering to a single copy videodisc (check disc) by LaserEdit, Inc., Burbank, CA. A pilot study, a small-scale version of the study procedures, is conducted to minimize the possibility of major difficulties with planned study methods. Both procedures and instruments are tested.

### Selection of Subjects

The study sample is N=36 volunteer baccalaureate nursing students from a state supported university. All generic baccalaureate nursing students enrolled during a particular semester will be invited to participate. Subjects are randomly selected from those students who indicate willingness (volunteer) to participate in the study. All volunteers attend a presession at which the study is explained. All attendees are given a consent form then asked to return it at the end of the session, whether it is signed or not.

Session I consists of subjects' completion of the MBTI. Following psychological type identification, subjects are randomly assigned to groups by psychological type; that is, to either the sensing (S) group or to the intuitive (N) group (approximately n=18 in each).

### Data Collection Procedures

The Myers-Briggs Type Indicator (MBTI) tool is completed in Session I by subjects in a group setting. They are scheduled for Session II at this time. Session II includes the CBVI treatment session. The study is administered to all subjects (both groups) at individually scheduled times thus: (a) computer-based demographic form; (b) computer-based screening pretest; (c) CBVI program with learner control options, including five embedded content questions; and (d) computer-based Adjective Rating Scale, ARS.

A computer-based screening pretest is administered. The purpose of this pretest is to screen for previous knowledge of the CBVI content on spiritual care. Items are validated for content and face validity established. Prior to the Pilot study, internal consistency reliability is established for the pretest items.

The computer-based video instruction (CBVI) program on spiritual assessment of clients is administered to each subject. (Prior to the Pilot study, the preliminary program is reviewed for content adequacy.) The CBVI program collects data on subjects' learner control decisions to (a) view more information about the section; and (b) see selected program segments again. There are eleven such learner control branching points.

Kelly's Adjective Rating Scale (ARS) measures subjects' attitudes toward the computer-based video instruction program and is done after learners complete the CBVI program. The ARS tool is a measure of course and program attitude that was developed by Kelly and others at the Center for Instructional Development at Syracuse University. The ARS was tested for four years on college students, with factor analysis revealing 5 dimensions: Interest Value, Practical Value, Emotional Appeal, Dullness (Apathy), and Difficulty (Kelly, 1976, p. 16).

### Overview of Expected Analysis

Data were not analyzed until after the PROCEEDINGS deadline; therefore, only fictitious data are published in the PROCEEDINGS. **Study data handouts** will be available at the formal paper presentation. Fabricated data were used for the following tables; these data were run on the computer for fictitious "individuals" as if the data were real. The chi square statistic is used to analyze two categories: (a) psychological type, and (b) types of learner control choices made by subjects. Subjects' responses are categorized by types of learner control choices for branches: (a) no control or (b) control. Table 1 presents a fictitious chi square table.

The statistical technique of analysis of variance (ANOVA) is used to analyze for differences in subjects' mean total scores and factor scores on the ARS by psychological type. Scores on Adjective Rating Scale are determined based on subjects' responses to items: 1 = extremely, 2 = very, 3 = somewhat, and 4 = not at all. The responses for fictitious data were totaled by the above values to determine scores for each of five factors: Practical Value, Emotional Appeal (Excitement), Dullness (Apathy), Interest Value, and Difficulty. Factor scores were also added together for a total ARS score. Table 2 presents a sample ANOVA analysis of fictitious test data for one factor. Table 3 presents fictitious test data for subjects' total scores (all five factors).

Table 1
**Fictitious** Chi Square: Learner Control Choices for Sensing and Intuitive Psychological Type

Chi Square = 4.012

degrees of freedom = 1 (corrected for continuity with Yate's Correction)

| TYPE OF LEARNER CONTROL CHOICE# | PSYCHOLOGICAL TYPE | | |
|---|---|---|---|
| | Sensing | Intuitive | Totals |
| No Control | 13<br>(9.5) | 6<br>(9.5) | 19 |
| Control | 5<br>(8.5) | 12<br>(8.5) | 17 |
| Totals | 18 | 18 | 36 |

*p=<.05

The figure in parentheses within each cell is the estimated expected frequency.
#Note: Scores for choices made by subjects: sum of number of view more or see again choices:
No Control = 0-5, Control 6-11+.

Table 2
**Fictitious** ANOVA: ARS Scores, Practical Value Factor, for Sensing (Sample 1) and Intuitive (Sample 2) Psychological Type

| SOURCE OF VARIATION | SS | df | MS | F-TEST |
|---|---|---|---|---|
| Between Groups | 393.361 | 1 | 393.361 | 20.983 |
| Within Groups | 637.389 | 34 | 18.747 | |
| Total | 1030.750 | 35 | | |

**p=<.001

Table 3
**Fictitious** ANOVA: ARS Total Scores for Sensing (Sample 1) and Intuitive (Sample 2) Psychological Type

| SOURCE OF VARIATION | SS | df | MS | F-TEST |
|---|---|---|---|---|
| Between Groups | 1708.445 | 1 | 1708.445 | 32.029 |
| Within Groups | 1813.555 | 34 | 53.340 | |
| Total | 3522.000 | 35 | | |

**p=<.001

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# MICROCOMPUTER-BASED TRAINING FOR MEDLARS DATABASES

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## ABSTRACT

CHEMLEARN, TOXLEARN, and MEDTUTOR are interactive, microcomputer-based training packages designed to teach librarians, information specialists, and other users how to search CHEMLINE, TOXLINE, and MEDLINE, respectively. The primary objective of these microcomputer-based training packages is to provide inexpensive, easily accessible, self-instruction as an alternative to formal classroom training. The menu-driven design of the training packages allows novice users to learn about the content and use of the databases at their own pace and with considerable program feedback. In addition, the training packages provide the skilled searcher with a way to reinforce or recall previously-learned search techniques without incurring on-line charges. CHEMLEARN, TOXLEARN, and MEDTUTOR may be used in place of formal training, or as a precursor to, or a refresher following formal training.

## INTRODUCTION

One of the most widespread applications of the computer is providing users with fast, easy, and accurate access to large quantities of information. The "database" application of computers has become increasingly important in a historical period known as "The Information Age." Rapid and accurate access to high quality information is particularly important to health professionals whose daily "life and death" decisions must be informed by the latest developments in medicine and a wide range of related fields, e.g., biochemistry.

In 1971 the National Library of Medicine (NLM) made available on-line access to its Medical Literature Analysis and Retrieval System (MEDLARS). This system was named MEDLINE (Medlars On-Line) (Kassebaum & Leiter, 1978). Today, MEDLINE is one of over twenty databases on the MEDLARS system and is accessed by over 30,000 users. It provides bibliographic information in the field of medicine, nursing, dentistry, veterinary medicine, and the preclinical sciences. TOXLINE (originally called TOXICON), a bibliographic file providing online access to over 2,500,000 citations covering the toxicological, pharmacological, biochemical, and physiological effects of drugs and other chemicals, has been publicly available since September 1972 and on MEDLARS since January 1974 (Schultheisz, 1981). CHEMLINE, an online chemical dictionary file, currently with names and Registry Numbers for over 850,000 chemical substances, was first made available on MEDLARS in January 1974 (Schultheisz, Walker, & Kannan, 1978).

NLM has been training search analysts since the original implementation of MEDLARS. Currently, several formal training courses on MEDLARS capabilities exist. Two of these, a three- to five-day modular introductory course entitled, "The Fundamentals of MEDLARS Searching," and a week-long modular sequel course entitled, "The Follow-Up to the Fundamentals of MEDLARS Searching," are geared toward librarians and information specialists who require extensive knowledge of the system's search capabilities. A third course developed by NLM specifically for health professionals, "The Basics of Searching MEDLINE," is a one-day search seminar designed **to explain** (as opposed to train) introductory-level, essential search techniques. As useful as these courses are, they have the drawback of requiring the search analyst to travel to a training site for a scheduled course which may be offered in their locale only one time per year. In addition to scheduling problems and travel costs, these courses do not permit the degree of self-paced instruction which some learners desire or need.

A mainframe computer-assisted instruction (CAI) program called *MEDLEARN* was designed in October 1976 (Eisenberg, Standing, Tidball, & Leiter, 1978) to meet the needs of searchers who wanted to learn basic concepts of searching MEDLINE in the privacy and convenience of their own offices. In 1979, a similar mainframe CAI program was developed for CHEMLINE (Spann, 1979). *MEDLEARN* is still available through the NLM mainframe computer to all searchers who have access to the MEDLARS system.

With the advent of personal computers, it became clear that yet another method of instructing searchers to use the MEDLARS databases would be perhaps more practical. Microcomputer-based training programs which do not require the expense and extra effort of communicating via modem with a centralized mainframe computer provide economical, convenient self-instruction for database searchers. Therefore, NLM has developed CHEMLEARN (Perkins, Spann, & Geasler, 1987), TOXLEARN Perkins & Spann, 1989), and MEDTUTOR (Perkins, Spann, & Buchan, 1989), microcomputer-based training programs, to address the needs of search analysts who want to learn or continue learning at their own pace, on their own equipment, in their home or office, and at an economical rate.

One of the few well-established principles of educational psychology is that people learn via a variety of styles, rates, and sequences. Whereas some people learn most efficiently in a group paced classroom environment, others benefit more from a self-paced, highly structured computer-based environment. At the same time, temporal and financial logistics may prohibit some potential users from availing themselves of in-person classroom instruction, and therefore, independent learning opportunities must be provided for them. As a result, the provision of computer-based tutorials such as MEDTUTOR, CHEMLEARN, and TOXLEARN are probably best regarded as one alternative type of learning opportunity in an "arsenal" of learning opportunities provided by NLM.

## CONTENT

Each of the three microcomputer-based training packages, CHEMLEARN, TOXLEARN, and MEDTUTOR, are organized into seven chapters which are divided into sections and subsections (see Figure 1). The introduction is presented in chapter one. Chapters two, four and six present information on the content and use of the particular database, followed by multiple choice and/or completion problems. Chapters three, five, and seven provide simulated searches which illustrate actual online sessions. In terms of context, chapter two covers the basic data elements. Chapter four presents more complex information. For example, in CHEMLEARN, chapter four presents the name and formula fragment data elements. In TOXLEARN and MEDTUTOR, chapter four presents a detailed discussion on the structure and use of MeSH, the dictionary of Medical Subject Headings. Chapter six in each of the training packages covers selected search limiters. The use of standardized lesson structures which obviously was useful during the training development process should also enhance the degree of learning from package to package. When students begin a second or third training program, they will feel much more comfortable with the familiar lesson structure having experienced it one or two times before.

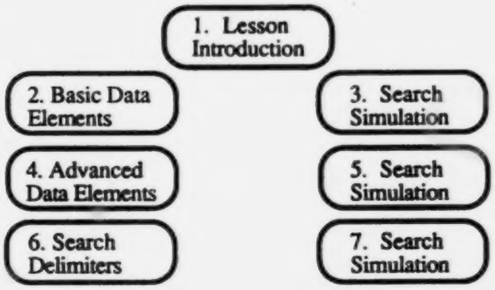
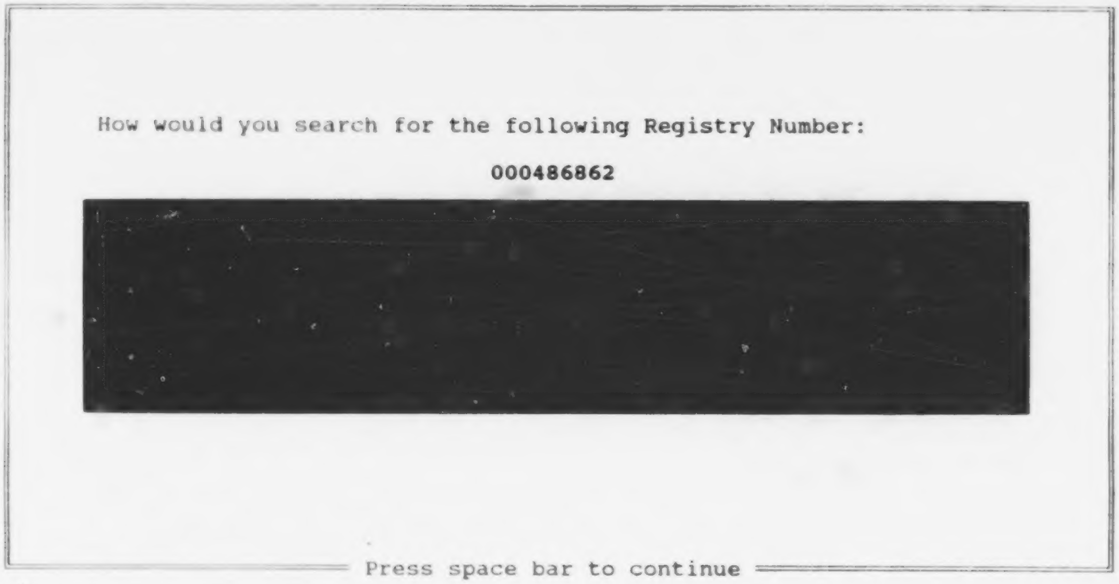


**Figure 1.** Lesson Structure for CHEMLEARN, TOXLEARN, and MEDTUTOR.

## INSTRUCTIONAL DESIGN

Perhaps one of the most important design aspects of CHEMLEARN, TOXLEARN, and MEDTUTOR is their systematic diagnostic feedback during practice. Users interact with the training packages as they would with the database itself, entering a letter, word, or phrase at the **USER:** prompt. The training packages responses are displayed following the **PROG:** prompt. User-specific feedback for correct and incorrect answers to both multiple choice and completion problems (Figure 2) is provided. When a correct answer is entered, the programs reinforce or summarize the concepts essential to the problem. When errors are made, the programs display diagnostic feedback and prompt the user to try again or have the correct answer provided. For completion problems, the programs match the user's entry to a list of anticipated errors that have been ordered according to probability of occurrence.

These rankings were established on the basis of observing learners construct searches with similar problems in classroom settings. Thus, problems and corresponding matching algorithms are designed to detect common errors derived from previous training experience.



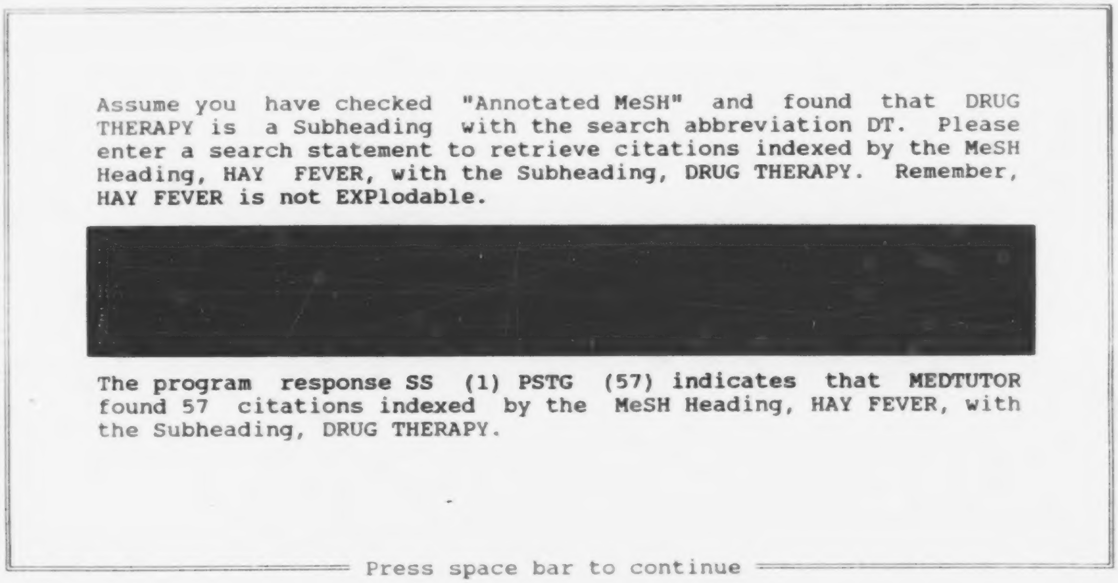
```
How would you search for the following Registry Number:

                     000486862
```

[redacted]

```
══════════════ Press space bar to continue ══════════════
```

**Figure 2.** CHEMLEARN Completion Problem Example.

In the simulated searches (Figure 3), the training programs detect incorrect search statements or commands and provide users the opportunity to reformulate their search strategy or have the correct search strategy entered automatically. The error diagnosing methods used in the programs are based upon the "learning misconception model" used in Intelligent Computer-Assisted Instruction (ICAI) programs (Burton, 1982).



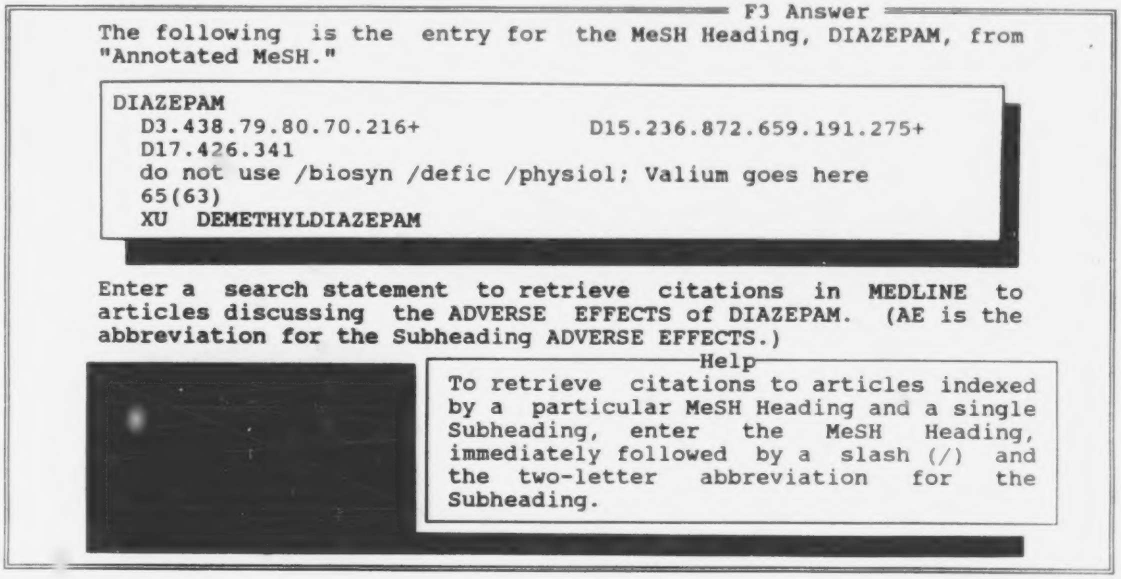
```
Assume you  have checked  "Annotated MeSH"  and  found  that  DRUG
THERAPY is  a Subheading  with the search abbreviation DT.  Please
enter a search statement to retrieve citations indexed by the MeSH
Heading, HAY  FEVER, with the Subheading, DRUG THERAPY.  Remember,
HAY FEVER is not EXPlodable.
```

[redacted]

```
The program  response SS  (1) PSTG  (57) indicates  that  MEDTUTOR
found 57  citations indexed  by the  MeSH Heading, HAY FEVER, with
the Subheading, DRUG THERAPY.

══════════════ Press space bar to continue ══════════════
```

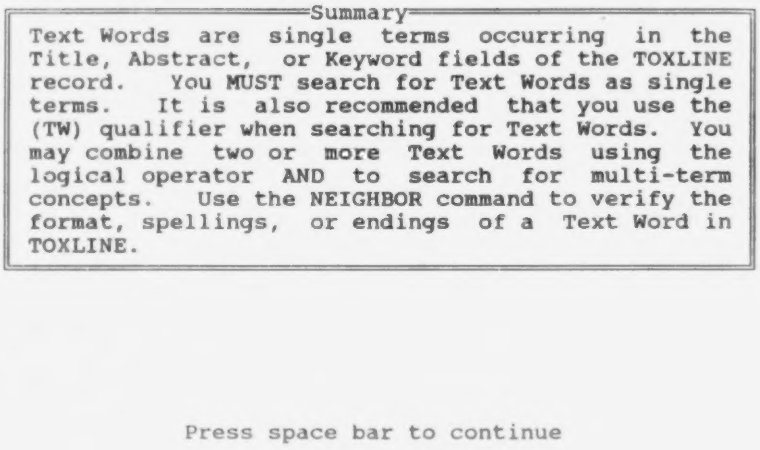
**Figure 3.** MEDTUTOR Simulated Search Example.

Optional information is provided throughout the programs. Optional HELPs (Figure 4) provide users with assistance in formulating responses to multiple choice and completion problems as well as in formulating search statements and commands in the simulated searches. Optional SUMMARIES (Figure 5) are provided throughout the programs. They are accessible from any point in the sections and provide an excellent means of on-demand review.



```
                                                  F3 Answer
The following  is the  entry for  the MeSH Heading, DIAZEPAM, from
"Annotated MeSH."

DIAZEPAM
  D3.438.79.80.70.216+          D15.236.872.659.191.275+
  D17.426.341
  do not use /biosyn /defic /physiol; Valium goes here
  65(63)
  XU  DEMETHYLDIAZEPAM

Enter a  search statement  to retrieve  citations  in  MEDLINE  to
articles discussing  the ADVERSE  EFFECTS of DIAZEPAM.  (AE is the
abbreviation for the Subheading ADVERSE EFFECTS.)
                                            Help
                           To retrieve  citations to articles indexed
                           by a  particular MeSH Heading and a single
                           Subheading,  enter   the   MeSH   Heading,
                           immediately followed  by a  slash (/)  and
                           the  two-letter   abbreviation   for   the
                           Subheading.
```

**Figure 4.** Optional MEDTUTOR HELP.

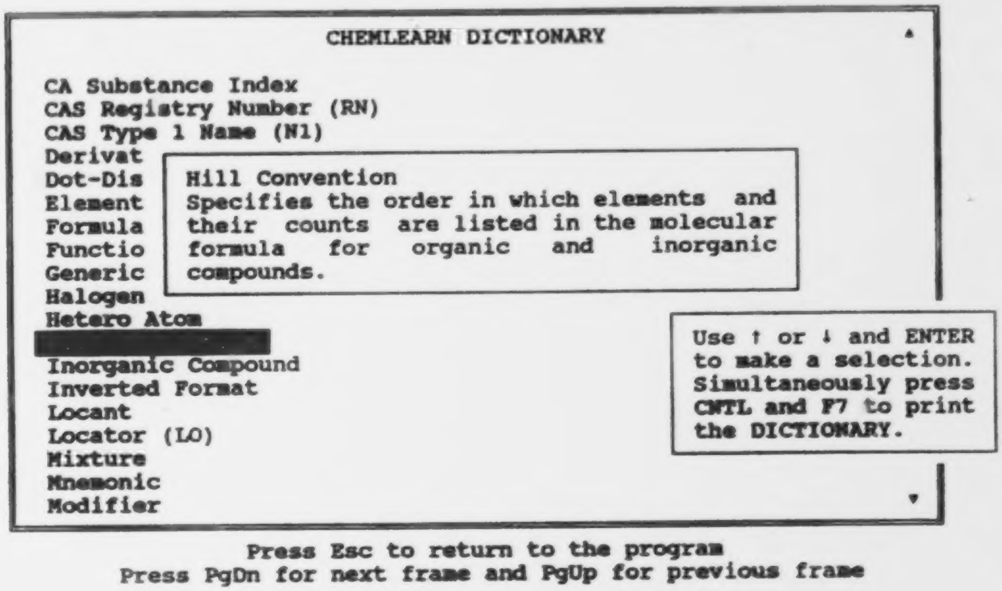


```
                        Summary
Text Words  are  single  terms  occurring  in  the
Title, Abstract,  or Keyword fields of the TOXLINE
record.   You MUST search for Text Words as single
terms.   It is  also recommended  that you use the
(TW) qualifier when searching for Text Words.  You
may combine  two or  more  Text  Words  using  the
logical operator  AND  to  search  for  multi-term
concepts.  Use the NEIGHBOR command to verify the
format, spellings,  or endings  of a  Text Word in
TOXLINE.




               Press space bar to continue
```

**Figure 5.** Optional TOXLEARN SUMMARY.

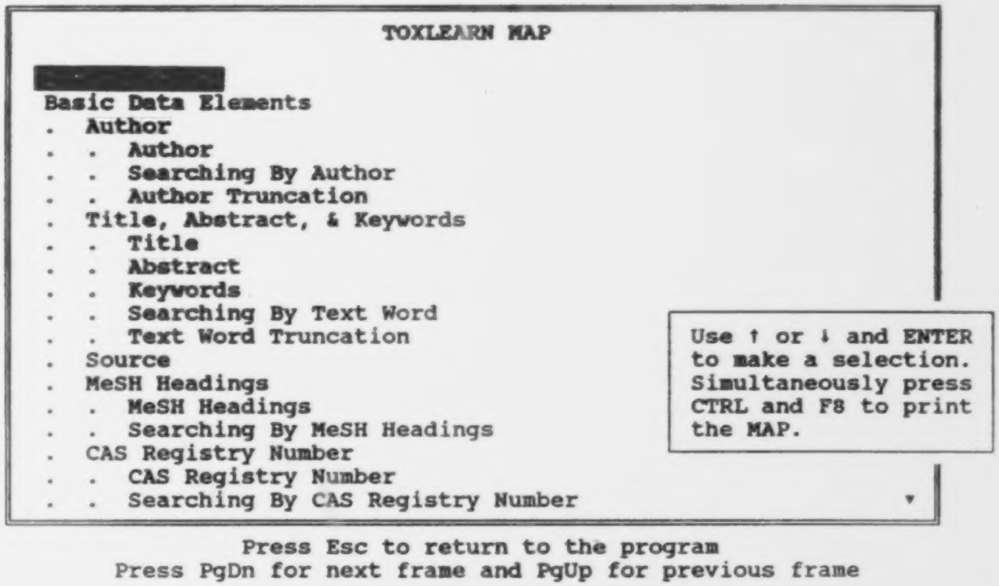
A DICTIONARY (Figure 6) enables users to quickly look up definitions for data elements, ELHILL commands, standard conventions, and publications referred to in the programs.

Menus and submenus are used to access chapters and topics within chapters. A MAP (Figure 7) displays a hierarchical listing of each of the sections in the programs. It serves as both an index and an overall menu. A tracking function monitors users' progress through each program.



```
                    CHEMLEARN DICTIONARY

CA Substance Index
CAS Registry Number (RN)
CAS Type 1 Name (N1)
Derivat
Dot-Dis   Hill Convention
Element   Specifies the order in which elements  and
Formula   their  counts  are listed in the molecular
Functio   formula   for   organic   and   inorganic
Generic   compounds.
Halogen
Hetero Atom
[illegible]
Inorganic Compound                   Use ↑ or ↓ and ENTER
Inverted Format                      to make a selection.
Locant                               Simultaneously press
Locator (LO)                         CNTL and F7 to print
Mixture                              the DICTIONARY.
Mnemonic
Modifier

             Press Esc to return to the program
      Press PgDn for next frame and PgUp for previous frame
```

Figure 6. A CHEMLEARN DICTIONARY Frame.



```
                         TOXLEARN MAP

[illegible]
Basic Data Elements
.  Author
.  .  Author
.  .  Searching By Author
.  .  Author Truncation
.  Title, Abstract, & Keywords
.  .  Title
.  .  Abstract
.  .  Keywords
.  .  Searching By Text Word
.  .  Text Word Truncation                  Use ↑ or ↓ and ENTER
.  Source                                   to make a selection.
.  MeSH Headings                            Simultaneously press
.  .  MeSH Headings                         CTRL and F8 to print
.  .  Searching By MeSH Headings            the MAP.
.  CAS Registry Number
.  .  CAS Registry Number
.  .  Searching By CAS Registry Number

             Press Esc to return to the program
      Press PgDn for next frame and PgUp for previous frame
```

Figure 7. A TOXLEARN MAP Frame.

As each section is completed, its corresponding menu and MAP entries are highlighted. Records are maintained on the progress of the twelve most recent users. This information is used in subsequent sessions to allow the users the option of returning to the point in the program from which they exited and to indicate the topics they had completed previously.

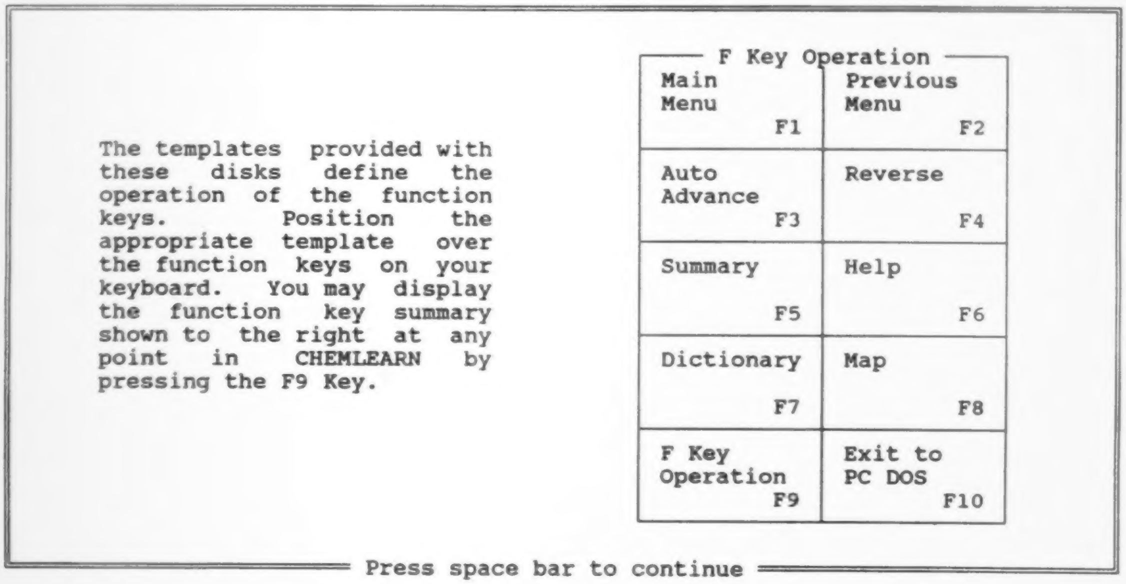
Movement among menus, access to the MAP and optional information, including HELP, SUMMARIES, and the DICTIONARY, as well as paging forward and backward through consecutive displays, automatically displaying user input, and exiting to DOS is accomplished by pressing function keys. Additionally, a window detailing each function key's operation may be displayed at any point in the programs at the press of a function key (Figure 8). CHEMLEARN, TOXLEARN, and MEDTUTOR maximize learner control of instruction by incorporating information aids, retrieval devices, and a friendly interface. This strategy has been shown to be particularly effective with sophisticated learners (Snow & Lohman, 1984; Tenneyson, Christensen, & Park, 1984), a factor especially important in training for professionals such as those in the health fields. Moreover, the high degree of learner control which allows users to quickly access the particular portions of the program related to their individual search requirements enhances the utility of the programs as vehicles for refresher training.

## IMPLEMENTATION

CHEMLEARN, TOXLEARN, and MEDTUTOR are programmed in NLM's version of PILOTplus. PILOTplus is a high-level authoring language designed to assist the professional educator in developing interactive, microcomputer-based courseware. It is based on PILOT, Programmed Inquiry Learning or Teaching, developed by John Starkweather at the University of California at San Francisco in 1969 (Starkweather, 1969, 1985).

TOXLEARN and MEDTUTOR were generated using the "NLM LEARN Programmer," a program which uses specially formatted ASCII script files and corresponding data files to produce finished PILOTplus code. Currently, it operates on a chapter by chapter basis without requiring user interaction. The data files contain a hierarchal listing of the sections in the chapter, the completion flag variable and the number of the first frame for each section, and a list containing the number and type designation for each frame in the chapter.

The programs resides on two or three 5 1/4" low density floppy diskettes or one 3 1/2" low density disk and requires 540K RAM and DOS 2.0 or higher. They may be loaded onto a hard disk or executed directly from the floppy diskettes. They run on IBM-PCs, PC-XTs, PC-ATs PS/2s and compatibles and support most monochrome, color-graphics and enhanced color-graphics monitors. No extra boards or external peripherals are necessary.



The templates provided with these disks define the operation of the function keys. Position the appropriate template over the function keys on your keyboard. You may display the function key summary shown to the right at any point in CHEMLEARN by pressing the F9 Key.

F Key Operation

| | |
|---|---|
| Main Menu F1 | Previous Menu F2 |
| Auto Advance F3 | Reverse F4 |
| Summary F5 | Help F6 |
| Dictionary F7 | Map F8 |
| F Key Operation F9 | Exit to PC DOS F10 |

Press space bar to continue

**Figure 8.** Function-Key Template Window.

## EVALUATION

Sophisticated databases such as MEDLINE, CHEMLINE, and TOXLINE are only worthwhile if the audiences for whom they are intended are using them. As with any technology, some training is necessary to make optimal use of these resources. To provide the necessary training, NLM has developed a variety of learning opportunities including formal classes, printed manuals, and computer-based training (CBT). As described above, MEDTUTOR, CHEMLEARN, and TOXLEARN are examples of the CBT initiative.

At the same time that NLM is providing training for users of its database resources, it is also endeavoring to make the databases easier to access and use. One example of this initiative is GRATEFUL MED, a user-friendly software package which allows offline search formulation and automatic conversion to proper searching formats for various NLM databases. In addition to allowing simple, direct access to databases, GRATEFUL MED requires no formal training.

Whether the future of improving overall access and use of online databases lies in friendlier interfaces or better training is a question facing NLM. More than likely, it is not an "either-or"question, but an issue of establishing the best blend of user interface support and learning opportunities. An evaluation is currently being conducted by Department of Instructional Technology at The University of Georgia to shed some light on these issues.

The specific purposes of this evaluation are:
1) assess the instructional design and functionality of MEDTUTOR, CHEMLEARN, and TOXLEARN, and
2) assess the effectiveness and suitability of computer-based training packages such as MEDTUTOR, CHEMLEARN, and TOXLEARN as means of instruction for the MEDLARS databases.

These purposes are related to three of the six levels of evaluation defined by Reeves (1989) for interactive training programs, formative evaluation, immediate effectiveness evaluation, and impact evaluation. **Formative evaluation** involves collecting the opinions, suggestions, and criticisms of users, developers, and others for purposes of revising and improving aspects of the training program. Formative evaluation is the essence of good instructional design, and it should be clear that substantial formative evaluation has already been accomplished during the development of MEDTUTOR, CHEMLEARN, and TOXLEARN.

**Immediate effectiveness evaluation** is carried out to assess the instructional effectiveness and efficiency of CBT within the immediate temporal and spatial contexts of its implementation. The goals and objectives of education and training can be classified as either immediate or long term. Immediate goals/objectives can be accomplished within the timeframe of the actual use of an instructional program, whereas long-term goals/objectives may not be accomplished until some time after the completion of a program. For example, an immediate goal of MEDTUTOR might be to teach physicians "how" to access MEDLINE when they need more information about unusual symptoms presented by their patients. A long term goal of the same program might be to encourage physicians to actually use MEDLINE in the context of their own practices. Immediate effectiveness evaluation is concerned solely with the short term effectiveness of the training, i.e., whether or not the trainees possess the new knowledge, skills, and attitudes at the time of completing the CBT.

**Impact evaluation** is the ultimate intent of most training evaluations, but this level of evaluation is the most difficult. It is relatively simple to determine, for example, whether physicians have learned methods of accessing a particular database within the immediate context of a training program. However, it is much more difficult to estimate whether the same program has resulted in increased usage of the databases by the participating physicians within the context of their clinical practices. Even if improvements can be detected, it is often impossible to establish causal links between specific instructional programs and improvements in real world performance because of the presence of plausible alternative explanations and numerous intervening variables.

If evaluation is to provide timely, accurate information to support decision-making, it must anticipate decisions that will be made (Reeves & Lent, 1984). (It is important to remember that most of these decisions **will be made** regardless of the quantity and quality of information available to the decision-makers.) The following decisions are anticipated for MEDTUTOR, CHEMLEARN, TOXLEARN and similar CBT packages at NLM:
a. Modifications will be made in the MEDTUTOR, CHEMLEARN, and TOXLEARN programs to improve their instructional effectiveness and efficiency.
b. Dissemination strategies for MEDTUTOR, CHEMLEARN, and TOXLEARN will be identified.
c. Efforts to develop training packages for other databases will be undertaken by NLM.
d. Resources will be allocated to the development and implementation of alternative training options (e.g., classroom training) and/or to the further development of user friendly interfaces (e.g., GRATEFUL MED).
e. Attitudes toward CBT programs such as MEDTUTOR, CHEMLEARN, and TOXLEARN will be formed at all levels of the medical community, including the NLM, NIH, and potential users of the NLM databases.

Obviously, this is not an exhaustive list of the decisions which will be made about MEDTUTOR, CHEMLEARN, and TOXLEARN and other CBT programs at NLM. There will always be unanticipated decisions. The basic philosophy of the evaluation approach being used in this study is that informed decision-making is better than uninformed or misinformed decision-making. Whenever decisions are made, questions are asked and alternatives are considered, formally and/or informally. In order to influence the decisions listed above as well as other unanticipated decisions, this evaluation must provide answers to a variety of questions which form the basis for "informed" decision-making.

A variety of evaluation designs and methods are being utilized to collect the information required to inform the decisions listed above. First, survey and record-keeping methods are being employed to address questions concerning the formative, effectiveness, and impact evaluation of the interactive training programs. These methods will provide the basis for establishing dissemination procedures for CBT programs and for guiding modification and improvements in the training materials.

Second, testing methods including in-basket exercises are being employed to address the immediate effectiveness of the CBT materials as used by potential users. Volunteer users have been sought from a variety of sources including professional organizations, VA hospitals, regional medical libraries, and so forth. Logs, interviews, questionnaires, tests, and in-basket exercises are being used as process and outcome measures. These methods will provide the basis for assessing the short and long term effectiveness of the training programs.

Third, interviews, questionnaires, and expert review are being employed to obtain qualitative assessments of the CBT packages in comparison to other training options, user-friendly interfaces, and other commercially available CBT packages. These methods will provide the basis for assessing the worth of MEDTUTOR, CHEMLEARN, and TOXLEARN from multiple perspectives.

## SUMMARY

Training programs have changed dramatically at the Library over the past 20 years. The introduction of microcomputer-based training packages as a training option increases the opportunities of current and potential MEDLARS search analysts for familiarizing themselves with the MEDLARS databases. It is envisioned that not only individual searchers will avail themselves of this method, but also that faculties at medical schools and universities might employ these training packages as a means of introducing their students to the mechanics of searching the MEDLARS databases, thereby eliminating the need to prepare and conduct formal training presentations. The future of training at NLM will undoubtedly include designing additional computer-based training programs for the other databases on the MEDLARS system. As in the past, the evolving nature of the NLM on-line databases and associated training programs will be guided by the creative efforts of developers and trainers and informed by the findings of systematic evaluation.

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# THEORETICAL AND EMPIRICAL SUPPORT FOR THE USE OF INTERACTIVE GRAPHICS AND ANIMATION TO TEACH MEDICAL STUDENTS

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## ABSTRACT

Medical school curricula has recently been criticized for its emphasis on fact memorization and lack of problem solving experience for students. This paper presents theoretical and empirical support for the use of tutor guided computer graphic simulation to improve the memory and recall of relevant concepts applied to medical problem solving.

## THE PROBLEM

It is estimated that scientific information is increasing at a rate of 13% per year and doubling every 5.5 years (Piemme, 1988). This translates directly into substantial increases in the content of medical school curricula and a memory overload for medical students. It is unlikely that the majority of facts presented to students during the preclinical years can be remembered. Furthermore, most of the facts taught during these years lack direct relevance to the types of problems a practicing physician encounters. Therefore, much of the time spent in teaching these facts is counterproductive.

Ultimately, a physician must solve clinical problems using problem solving skills rather than rote memorization. He/she must selectively gather, analyze, and apply knowledge for each unique situation (AAMC, 1984). Medical diagnostic competency requires a deep understanding of specific concepts and principles gained through active problem solving experience. Unfortunately, physicians who are beginning practice are ill prepared to reason analytically and to resolve medical problems effectively. This deficiency is directly attributable to the instructional methods currently implemented by medical schools.

Typically, the first two years of medical school are comprised of lectures and textbook instruction. The concepts and principles learned during these years must then be applied to the associative types of reasoning necessary for patient diagnosis in years 3 and 4. Generally, however, there is no formal instruction to help the student integrate these two types of knowledge. According to the GPEP report (AAMC, 1984), some medical schools have adopted problem solving methods of teaching that "emphasize the formulation of hypotheses, the critical evaluation of data, and the integration and application of new knowledge to the analysis and solution of problems." Faculty members guide the student in development of problem solving strategies. A widespread implementation of these nontraditional teaching strategies is warrented.

The physician must recall or gain access to vast amounts of facts, concepts and principles and apply them to a variety of problem solving situations. Emphasis should be placed on those instructional strategies which will aid in deep understanding and long-term retention of knowledge. Therefore, problem solving experience must be provided without endangering the patient. Research is needed to identify the conditions and instructional techniques which can maximize these types of learning.

To summarize, the objectives of medical school curricula should include the development of instructional strategies which promote:

1. Efficient information acquisition by the student.
2. Long-term retention of concepts and principles.
3. Easy retrieval of information for problem solving.

4. Active and independent experience by the student in knowledge acquisition and problem solving.

## MEDICAL PROBLEM SOLVING -- CAN IT BE TAUGHT?

With the growing attention to problem solving, many researchers have attempted to identify the cognitive processes used in medical diagnosis. Educators have used this research data as a framework to develop teaching strategies designed to more effectively prepare students for clinical decision making. The basic assumptions are that general problem solving strategies can be taught.

Investigators have defined the clinical decision making process as a sequential hypothetical/deductive process that includes preliminary problem recognition and analysis, development of initial hypothesis, hypothesis oriented inquiry and further hypothesis refinement, proceeding until a coherent model of the patient has been formed, bringing the problem to closure (Barrows, 1988; McGuire, 1985). Gagne (1985) describes problem solving as a process by which previously learned rules are applied to a novel problem. The subject actively tests the applicability of a number of hypotheses until a solution is found. Beck and Bergman (1986) found that those students instructed in problem solving skills were able to solve patient case studies accurately using less information than the control group. These authors cautioned, however, that early hypothesis generation may lead to the risk of premature closure and error.

Barrows (1988) found problem-based teaching strategies superior to other strategies commonly utilized by medical institutions. In problem-based environments the student is provided with a clinical problem in simulation format that allows for student inquiry. Usually, tutor guided exploration and evaluation of the problem serves to activate the student's prior knowledge. This in turn facilitates the understanding and retention of new information. This approach is entirely student centered, motivating and is highly regarded in the achievement of learning objectives.

Despite evidence that problem-based simulation is the most effective learning strategy, a combination of approaches may be more pragmatic. Teacher centered learning may be optimal early in a curriculum where students need to receive initial information essential for later problem solving. A well planned balance of problem solving and traditional lecture methods would appear to be optimum.

## GRAPHICS CAN POSITIVELY INFLUENCE LEARNING AND RECALL

There is a visual side to much of what is taught in medicine -- a side which has largely been neglected in formal instructional settings. It is estimated that about one half of the human brain's neurons are associated with visual input (McCormick et al., 1987). Utilizing the learner's visual processing capabilities could theoretically optimize his/her ability to cope with new information.

The dual coding theory proposed by Allen Paivio (1983) suggests the existence of two distinct memory systems in the human brain -- one verbal and one visual. According to the theory, words and pictures can independently activate verbal and visual memory systems. These two systems are thought to be functionally interconnected. Therefore, activity in one system can initiate activity in the other. Redundant encoding (ie. recording both verbal and visual representations of information) may increase the probability of information retrieval because if one memory system fails, the other will still be available (Rieber, 1988). Emperical research supports the notion that information presented to the learner through both verbal and visual means is more likely to be recalled compared to only verbal or visual presentation (Kosslyn, Huffman, and Holyoak, 1976; Paivio and Csapo, 1969).

The dual coding perspective on memory storage and recall reinforces the need for visuals in instruction. Extensive research shows superior learning from illustrated vs. non-illustrated text materials. Of 46 experiments reviewed by Levie and Lentz (1982), 85% showed significant improvement in learning from illustrated vs. non-illustrated text. In addition, these reviewers found that the superiority of illustrated text was more pronounced for delayed recall than immediate recall. The average learning gain determined in delayed recall tests was 5 times greater as compared with immediate recall tests. Several studies have shown that providing the learner with relevant pictures before and during a learning session facilitated science learning (Arnold, Dwyer, 1975; Holliday, 1975; Rigney, Lutz, 1976; Weisberg, 1970). Holliday observed that high school science students learned 30% more from text passages which included relevant diagrams (Holliday, 1976).

## WHAT MAKES VISUALS UNIQUE?

The message seems clear. Visuals can have a positive effect on learning and in many cases are superior to propositional (verbal) information. What is it about visuals that make them unique? Whereas verbal information must be processed by the brain linearly, visual information can be processed in parallel, giving the perception of instantaneous access to large amounts of information (Larkin, Simon, 1987). This notion is echoed in the following statements. "The limited capacity of working memory can frequently impair our ability to understand information, to solve a problem, to investigate and explore, or to carry out other kinds of thinking. The importance of graphic information is that it frequently removes this memory limitation." (Phillips, 1986). This is particularly true of visuals such as maps, diagrams, graphs, and organizational charts. In a diagram, information is organized by location. Therefore, problem solving can proceed through a smooth traversal of the "diagram and may require very little search or computation of elements" (Larkin, Simon, 1987).

## ANIMATED GRAPHICS

To optimize a medical student's ability to cope with the voluminous information of the curriculum, maximal use should be made of his/her visual processing capabilities. Therefore, pictures should be supplied at rates fast enough to utilize the high bandwidth of the brain's visual data paths (Levine, 1988). "Interactive computer graphics allows us to achieve much higher bandwidth man-machine communication useing a judicious combination of text with static and dynamic pictures than is possible with text alone. This higher bandwidth makes a significant difference in our ability to understand data, perceive trends, and visualize real or imaginary objects" (Foley, Van Dam, 1984).

Visualization in scientific computing has gained momentum over the past few years within the scientific community in tandem with advances in computer graphic technology. Scientific visualization can be thought of as a method which "transforms the symbolic into the geometric, enabling researchers to observe their simulations and computations." (McCormick et al., 1987, p. 68). Its goal is to provide new insights through imagery and to enrich the process of discovery by enableing the scientist to see what has never been seen before (McCormick et al., 1987). Visualization can also be a powerful discovery tool for students. According to Cunningham et al., (1989, p.3) visualization applied to instruction is "the use of images and graphics in a highly interactive and dynamic manner to ... [significantly enhance] ... the learning and understanding process." The student is empowered through interactive simulated experience to discover for him/herself what would otherwise be impractical or impossible to experience. It has been found that dynamic graphics which add to the realism of a simulation can contribute to this learning experience and to the transfer of skills to actual problem solving (Fleming, Levie, 1978; Gagne, 1954; Osgood, 1949; Ruben, Lederman, 1982; Schneider, 1985; Williges, Roscoe, Williges, 1973; Wolfe, 1978).

In the process of patient diagnosis, medical students must interpret lab data. Many of the underlying processes affecting lab results occur on a cellular and molecular level. Students often find it difficult to visualize the interaction among these variables based on the current instructional materials and consequently are unable to effeciently analyze the data. Students taught visual thinking skills through the use of interactive computer graphics may be better equipped to interpret such data and to make accurate diagnoses.

## INTERACTIVE SIMULATION

Simulation is defined as the simplified representation of the operation of a real world system over hypothetical time (Mandinach, 1987). An interactive computer based simulation can provide the learner with a display or model of specific processes relevant to clinical problem solving. The student may have active control over certain aspects of the simulation and may choose to alter specific variables and make predictions as to the outcome of these changes. He/she can then witness the evolution of these processes and gain a global picture of system elements (Sorensen, 1988). For the first time he/she may be able to visualize complex relationships among the variables.

Guided by an intelligent tutor, a simulation can explain and interpret for the student the underlying principles which led to displayed outcomes and can help the student gain deeper levels of understanding. Active experience with problem solving in a simulated environment can be gained as the tutor interface guides and coaches the student in deducing solutions (Bork, 1981; Reed, 1985).

## NOT ALL VISUALS ARE EFFECTIVE FOR ALL LEARNERS

It is known that the effectiveness of an instructional intervention may depend on the cognitive skills of the learner. Salomon (1979) identifies ways that symbolic codes of media can be used as instructional interventions which support learner cognitive processes to facilitate learning. The symbolic codes of an instructional intervention may aid the learning process by providing a format which closely matches the learner's cognitive abilities. Depending on the familiarity of the learner with the content, the nature of the content to be presented and the learner's learning style, one of these processes may more readily support learning than another.

Learners who have mastered a particular mental transformation may benefit from seeing a static image which models the initial state of the process. This image may serve to activate the entire transformational process in the mind's eye of the learner. This is what Salomon calls activation. Such transformational skills are necessary for a physician to interpret a CAT scan or an EKG.

Blueprinting, a phenomenon described by Sheffield (1961), closely parallels Salomon's activation process. Blueprinting is the recall of a total stimulus object caused by a representation, picture or symbol of that object. For example, the architect is able to visualize the completed house after seeing the floor plan. Phenomena involving a complex hierarchy of interrelated events which are sequential in nature can more readily be recalled by the learner when presented schematically rather than linearly through text. The learner can then refer to the mental blueprint to trigger recall of the relevant elements for a particular problem solving task (Caldwell, 1973). The blueprint provides a kind of map of the whole which the learner can use as a reference while organizing the parts. Charts and diagrams have been shown to be effective tools in presenting a logical structure for knowledge in a spatial format which may correspond to the way certain learned information is stored in the brain (Winn, 1983). These visual devices can aid the medical expert who depends on the use of well organized knowledge.

Some coding elements (ie. animation, slow motion cinematography, zooming, etc.) can model an entire process for the learner. Depicting a process for the learner can aid the learner in visualizing the process on his own. Through supplantation, a mental image can be internalized, stored, and made available to the student for later use (Salomon, 1979). This type of modeling is more of a benefit to the unskilled or naive learner who cannot carry out the transformation on his/her own. According to Salomon, this modeling operation supplants the process which the learner has not yet mastered. Salomon reasons that viewers who repeatedly observe such transformational codes will eventually internalize the codes and be able to apply then to new situations.

Students learning to read CAT scans may benefit from viewing interactive animations where sections of the brain are manipulated and viewed in relation to the entire brain. Similarly, students who are unfamiliar with a process such as the complement cascade in transfusion medicine may benefit from seeing the steps animated. The learner already familiar with complement activation, however, may only need to see a static image in order to recall an entire phase of the process. Viewing the entire process may be unnecessary and in fact may hinder learning for this experienced student.

## EVIDENCE SUPPORTING THE USE OF ANIMATED GRAPHICS

In a study conducted by Rigney and Lutz (1976), students whose written instruction incorporated animated visuals performed better on recall tests than students who received written instruction. The visual instruction group reported that the animated graphics helped them to visualize the material presented while the verbal instruction group did not report such a phenomenon. Salomon might argue that supplantation took place for the visual group, in that animated graphics supplanted mental processes which later aided the student in productive recall of concepts.

Empirical studies support the use of animation to improve learning in the fields of electrochemistry (Rigney, Lutz, 1976), mathematics (Layne, Baek, 1988), and physical science (Rieber, 1988). Layne (1988) speculates that studies which show no improvement in learning from animated instructional materials may have failed to focus lesson objectives on information revealed through animation.

Animation can be an effective instructional tool when it is used to illustrate principles which are highly visual in nature and which involve the attributes of motion, transformation, or time. Many concepts in medicine involve molecular interactions which entail transformations or shape changes over time. Often complex interactions among variables are also involved. Medical students may not be able to imagine these processes on their own and therefore may have difficulty understanding underlying cause and effect relationships. Computer generated animation is suitable for depicting these processes which cannot be seen. Therefore, animated graphics can arouse or supplant mental processes in the learner's long term memory and supply him with a vivid image-based memory store to use during problem solving.

## SUMMARY OF RESEARCH FINDINGS

To adequately prepare medical students for professional practice, improvements in medical school curricula have been prescribed. Changes in instructional objectives and strategies which cultivate the physician's problem solving and diagnostic skills can ultimately impact on the quality of patient care. Many theories and empirical research findings in the fields of education and cognitive psychology have been reviewed in an effort to determine the most useful instructional strategies and media for achieving this goal.

The dual coding theory backed by empirical research dictates the use of combined verbal and visual instructional materials. Numerous research studies justify the use of graphics in conjunction with audio or written information to improve learning, retention, and transfer of knowledge. The supplantation theory lends support to the use of animation to aid learner visualization of temporal processes. Since many of the processes to be learned in medicine are of a temporal nature, a medium such as computer animation which can emulate the desired movements and transformations should be used to depict them. That mental imaging can be prompted by the sight of a graphic add support to the blueprinting and activation theories and the usefulness of diagrams to teach. Finally, simulated environments have been effective in providing the student with interactive practice and the potential for transfer of skills to actual situations. Advances in computer technology have significantly increased the speed of computer/user interaction and the level of graphic realism that can be achieved in a simulated environment.

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# COMPUTER APPLICATION FOR TEACHING TIME MANAGEMENT AND RESEARCH BASICS

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## ABSTRACT

This paper focuses on a computer application in an undergraduate resource management course. The objectives of the project are to: (1) give students a computer experience, (2) use the computer as a calculation tool for analyzing personal time use, and (3) expose students to research methodology including the use of computers for basic statistical analyses.

## INTRODUCTION

Producing undergraduate students with some computer experience and exposure to research methods are two objectives of the College of Home Economics at Oregon State University. In a core course, **Management of Resources**, students complete a project designed to help meet these two goals in addition to evaluating their time management.

The Management of Resources class is a new core course beginning Fall '88 and is taken by all home economics students in their junior or senior year. The course is taught every term and each class is limited to 50 students. Most students are female and typically 20-22 years of age.

## COMPUTER SOFTWARE

The software used for this project is **Point Five** published by Pacific Crest Software. Point Five is an analysis and modeling system, much like a "word processor" for numbers. With a word processor, you can use the power of the microcomputer to arrange letters, words, sentences, and paragraphs into meaningful text. With Point Five, you can use the power of the microcomputer to arrange data, functions, statements, and models into meaningful numerical information. The five functions included in this program are: calculator, analysis, modeling, graphics and an applications development system.

Point Five was selected for several reasons. A major reason is that Oregon State University purchased the site license and the program is available to students through the campus laboratory computers or by receiving copies of the program to use on their personal IBM compatible computers. In addition, the program provides the flexibility of entering data, performing calculations, rearranging data, creating tables and graphs and analyses of data in a simple, straightforward and logical manner.

## PROCEDURES FOLLOWED

### Time Study

The students record their time use for one week during the 5th week of the term using the operational definitions and daily time record sheets designed for the project. The operational definitions are classified into five major categories: university, homemaking, employment, leisure and other and sleep. The sub-headings under each category are listed in Table 1. The daily time records are divided into 10 minute time intervals running from midnight to 11.50 p.m. The activities are coded by numbers 1 thur 20 (Table 1) and recorded daily by the students.

Because the majority of students have had no or very limited computer experience, the time use computer program and instructions were developed to provide straight forward data entry and

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calculations. Students are allowed to sign up for a computer laboratory session conducted by the graduate assistant or to complete the assignment on their own.

Each student enters his or her daily time use data by activity code in ten minute time segments. After the data have been entered for all seven days, the computer calculates the total time spent in each activity for each day. In addition, the total time spent in the 20 activities are totaled for the week (Example illustrated in Table 2). Students also have the option of graphing their time use patterns to assist in visualizing and interpreting their data. The entire procedure takes about 20 minutes to one hour.

All students' weekly time use is entered in an aggregate program to get class daily and weekly averages of all activities. This information is duplicated and given to class members for discussion and analysis.

## Research

After analysis of the class time use, lecture time is devoted to presenting methodology and findings of national time studies. Discussion includes: (1) why time studies are conducted, (2) problems associated with conducting such studies, and (3) compariso of time use studies.

To expose the students to an application of research methods, the instructor leads them through the research design process. Students are asked to develop a research question and develop hypotheses to be tested. Basic demographic information and student perceptions of personal management, housing arrangement, money use and personal management are collected in a survey administered at the beginning of the term and are used as variables for developing the hypotheses. Through this process students quickly become aware of sample limitations due to the homogeneous nature of the group including age, gender (predominantly female), class standing and university major. Examples of hypotheses include: (1) there is no difference in GPA and time spent in studying; (2) there is no difference in current housing tenure and total time spent in home making activities.

Appropriate statistical analyses are then conducted using Point Five. Students write up their findings, discussion and conclusions.

## CONCLUSIONS

This learning activity provides students who have no or very little computer experience with a positive computer experience breaking down some of the intimidation and fear of computers. The computer instructions are clear and easy to follow eliminating frustration experienced by many first time computer users. For experienced computer users, it introduces them to a new software program and new computer tools.

Having the students enter their own time use data on a computer eliminates having to: (1) do hand calculations and (2) hire someone to enter the data used for class analyses. It also provides a data base which can be used for research purposes. By actively participating in the research process, the students gain a greater appreciation and understanding of the research process. Feedback from the students has been very positive. They report the time spent at the computer is productive and educational.

TABLE 1. Time Use Categories

| Code | |
|---|---|
| | University |
| 1 | Class |
| 2 | Organization |
| 3 | Transportation |
| 4 | Study |
| | Homemaking |
| 5 | Meal Management |
| 6 | Dishwashing |
| 7 | Clothing Care |
| 8 | Family Care |
| 9 | Housing Care |
| 10 | Shopping |
| 11 | Other Homemaking |
| 12 | Employment |
| | Leisure and Other |
| 13 | Dating |
| 14 | Eating |
| 15 | Personal Care |
| 16 | Recreation |
| 17 | Other |
| 18 | Time Unaccounted For |
| 19 | Personal Transportation |
| 20 | Sleep |

TABLE 2. Time Use Summary

| | Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday | Total Minutes |
|---|---|---|---|---|---|---|---|---|
| 1 | 12.00 | 7.00 | 12.00 | 7.00 | 7.00 | 0.00 | 0.00 | 45.00 |
| 2 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 3 | 9.00 | 2.00 | 4.00 | 3.00 | 2.00 | 4.00 | 2.00 | 26.00 |
| 4 | 27.00 | 0.00 | 9.00 | 0.00 | 0.00 | 0.00 | 11.00 | 47.00 |
| 5 | 2.00 | 4.00 | 4.00 | 4.00 | 1.00 | 0.00 | 3.00 | 18.00 |
| 6 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 7 | 0.00 | 0.00 | 11.00 | 0.00 | 0.00 | 13.00 | 0.00 | 24.00 |
| 8 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10 | 4.00 | 2.00 | 3.00 | 15.00 | 3.00 | 8.00 | 0.00 | 35.00 |
| 11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 12 | 16.00 | 0.00 | 0.00 | 0.00 | 0.00 | 31.00 | 2.00 | 49.00 |
| 13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 14 | 3.00 | 3.00 | 5.00 | 8.00 | 5.00 | 2.00 | 5.00 | 31.00 |
| 15 | 14.00 | 7.00 | 16.00 | 6.00 | 13.00 | 7.00 | 6.00 | 69.00 |
| 16 | 15.00 | 41.00 | 33.00 | 52.00 | 52.00 | 17.00 | 42.00 | 252.00 |
| 17 | 0.00 | 14.00 | 0.00 | 0.00 | 0.00 | 1.00 | 7.00 | 22.00 |
| 18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 19 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 20 | 42.00 | 64.00 | 47.00 | 49.00 | 61.00 | 61.00 | 66.00 | 390.00 |

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# IMPACT OF COMPUTER CONFERENCING UPON REFINING PROBLEM-SOLVING SKILLS

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## ABSTRACT

This paper focuses upon a recently developed mechanism for assisting students to refine their analytical skills utilizing a computer network. A conferencing strategy was adopted for students in consumer economics to communicate electronically with one another while attempting to make an informed proposal for coping with a current dilemma in the marketplace. The resulting electronic extension of the classroom reflects the beginning of a new era in undergraduate instruction and student interaction.

## USE OF COMPUTERS BY STUDENTS

According to the October 1984 Current Population Survey conducted by the U.S. Census Bureau, 13 million adults who were in school or college in the fall 1984 (approximately 31 percent) were utilizing a computer while attending an educational institution. (1) Typically, at post-secondary institutions, word processing applications dominate student usage. Although the use of software related to spread sheets and data base management appears to be on the increase on campuses throughout this nation, there remains a lack of attention to utilizing computer networks as a "people connection tool" as project work and/or formal research efforts are conducted by undergraduates. To Joe Nathan, author of Micro-Myths: Exploring the Limits of Learning with Computers, the potential for computer utilization in a school setting is enormous--but mostly unrealized. In view of Nathan's perception, the learning mechanism recently devised at the University of Delaware is an attempt to include an innovative application of existing computer technology by "exploiting the power" of electronic conferencing.

Traditionally, students when assigned a problem to research conduct their investigative efforts primarily in isolation; that is, isolating themselves from others while searching for information. By following this study procedure, each student typically decides the strategy to be adopted, gathers information from a variety of personally selected references, and then, perhaps, keyboards the final findings into a project report in an acceptable style reflecting knowledge of research writing. This similar style of conducting research is often repeated in other classes as the student advances from year to year in his/her major.

However, it is suggested here that performing in isolation is generally not how society, and particularly individuals in business and industry, gather information for making recommendations to solve issues identified in the marketplace. In reality, just the opposite usually occurs; that being, conducting and working with others (perhaps in a group) for gaining a proper perspective as to what direction to take and what kinds of resources to gather. It is contended here that if the best solution is to be adopted, a reliance upon a team effort (through a continual interaction process) may be required as the complexities of both the business and social environment come into play. The "art of networking," whether by telephone, group meetings, or computer conferencing, has emerged as a timely alternative for permitting individuals in decision-making capacities to reduce the time and effort in gathering advice and information for solving the complex issues generally characteristic of today's marketplace.

## CONFERENCING METHODOLOGY

Recently, a preliminary design for incorporating an electronic interactive strategy was devised for enabling students to refine both analytical and problem-solving skills. An electronic conferencing strategy revolves around the discussion of an operational dilemma in the marketplace that is presented in conferencing notesfile which may only be accessed by designated students by means of a names file. Students access the notesfile each day, read the comments keyboarded, respond by keyboarding messages to one another (sharing their comments with others), and make a recommendation for a public policy. At a designated time culminating the end of the study, students keyboard their position by means of electronic mail (privately) to the instructor, using 200 words or less. No expectations on the part of the instructor are indicated as to the amount of time each participant is to devote each day to interacting electronically from a personal computer. However, students are permitted to interact with the class instructor at specified periods during each day. They are advised to interact with one another between 8:00 a.m. and 8:00 p.m. each day of the week (including weekends). Finally, students are advised not to discuss any aspect of the study project with anyone else when performing complementary activities away from their personal computer.

## SUGGESTED GUIDELINES FOR IMPLEMENTATION

Personal observations and feedback from a select group of students who reacted to the conferencing mechanism resulted in the development of a set of guidelines which should be adopted as a more formal experiment is carried out in the future. Since this strategy was an initial attempt into a new form of student interaction, these guidelines provide some structure to the process which may increase the likelihood of success.

1. Because of the varied interests of students, it is advisable to have more than one operational dilemma be placed into a notesfile while electronic conferencing is being executed. Such a practice would allow students to focus their attention by having the opportunity to select a particular issue for study--rather than having to focus on one issue only. Therefore, the recommendation here is to incorporate flexibility into conferencing by establishing several notesfiles by means of a menu to permit students to select a topic of interest.

2. In order to maintain an active interest on part of students over a sustained period of time (in this instance, a 4-week period), the introduction of a debating format is advised. In such an instance, by having students seek out an individual with an opposing point of view during the conferencing aspect of problem-solving, the resulting "adversial design" requires students to defend their positions which results in opportunities for applying analytical skills. Having such a requirement adds an important dimension of justifying one's position constantly on a daily basis, which appears to be an excellent format for refining both questioning and responding skills of students. In addition, the "debating aspect" requires the student to exhibit a considerable degree of both discipline and curiosity (in that she/he is likely to become anxious to read what the other party is keyboarding). The curiosity associated with such a conferencing strategy permits the inclusion of an intriguing element for motivating individuals to be responsible for providing meaningful input throughout the entire 4-week period.

3. It is also advisable to permit students to access the class instructor each day during the conferencing mechanism. By specifying access times, students may clarify misconceptions and thus reduce their "waste time" by getting advice to assure that they are proceeding in a proper manner. Such an opportunity also permits the class instructor to monitor student interaction and include comments to "excite" students into greater in-depth analyses.

4. Because electronic technology does not always perform the way it is expected to do, it is vital to have administrative support personnel on-hand during the "active moments" of conferencing. This availability permits students to gain access to an individual who can immediately solve technical problems with equipment, etc., without having to leave their personal computers.

5. Since it is expected that most students have had very little, if any, prior experience conferencing electronically, it is vital to have a comprehensive orientation to the system before the formal assignment is made. Personal observations reinforce the necessity of having at least a 3-hour preparatory period in which students are permitted to learn the terminology, sequences, and procedural idosyncras-

ies associated with the software in use.

6. For evaluative purposes, it is quite feasible to have all comments of students "stored" for review at the end of the activity by the classroom instructor. (It should be noted that a detailed analysis is currently being undertaken in this regard in an attempt to establish an appropriate formal research design for analyzing data to be collected as a conventional experiment is to be conducted on an expanded basis in consumer economics in the near future.)

## REFINEMENT OF PROBLEM-SOLVING SKILLS

The mechanism of electronic conferencing adds an interesting dimension to the instructional process. Students interacting with both the class instructor and other students are "forced" to utilize analytical, synthesis, and evaluative skills reflecting a more sophisticated level of learning. The ability to think, analyze, and compose comments and questions at a keyboard presents an extraordinary challenge to the undergraduate student. The necessity of keyboarding in precise terms challenges the writing abilities of such individuals.

It is being suggested that a continuous exposure to conferencing throughout an individual's undergraduate learning experience should result in the refining of problem-solving which are also quite critical for performing effectively in today's highly competitive marketplace. It is contended here that electronic conferencing enables students to apply what has been previously learned, rather than simply memorizing facts and figures which may be "regurgitated" back to the classroom instructor during a formal written examination. Although the above premise is based only upon a preliminary investigation of electronic conferencing and its possible feasibility as an alternative to traditional forms of student interaction, the knowledge gained should result in a more formal research design that may be adopted for an expanded version in the future.

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# Factors Influencing Computer-Aided Clothing and Textile Instruction in Secondary Home Economics Programs in Arkansas

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## ABSTRACT

A survey was conducted to assess computer aided instruction for teaching clothing by seconday home economics teachers in the State of Arkansas. Data were collected by a written questionnaire mailed to a random sample of 200 home economics teachers, of which 118 or 59% responded.

Based on the findings of this study, computers are available for student use for the study of clothing in approximately four-fifths of the high schools in Arkansas. The average amount of student usage in clothing instruction is approximately one and one-half hours per semester. Software appropriate to the clothing subject area is the greatest perceived need of high school home economics teachers for implementing computer aided instruction in their clothing programs.

## COMPUTER-AIDED CLOTHING INSTRUCTION
ROGERS, THOMPSON, AND COTTON

The computer is an innovative teaching tool that may be used in the instruction of clothing and textiles by secondary home economics teachers. Five states have passed laws mandating computer skill requirements of students. Arkansas is one of six states in the United States, that requires teacher training in microcomputer usage (West, 1985-86).

The impact of computers on our society has been compared to technological developments such as the television, the printing press, and the telephone (Browning & Durbin, 1985; Offerjost & Terry, 1987; Wiltse, 1986). Many people believe that by the 21st Century, computers will be as common in American homes as telephones (Browning & Durbin, 1985) and television sets are today (Quiring, 1984; Wiltze, 1986). The use of computers has increased in secondary schools across the U.S. from 42.7% in 1981 to 97.3% in 1985 (Statistical Abstract of the U.S., 1987). Educators have the responsibility to not only be computer literate, but also help students become computer literate.

The Vocational Technical Division of the Arkansas Department of Education is revising curriculum guides for home economics clothing and textiles programs in the state of Arkansas. The use of the computer as a teaching tool for clothing and textiles curriculum will provide classroom experiences for students to learn more about the subject and gain computer skills.

This study was designed to obtain a description of the current use of the computer as a tool for teaching clothing and textiles and to gain insight into the perception of home economics teachers regarding it's future use.

The study sought to describe computer use for teaching clothing and textiles in high school home economics programs in the state of Arkansas; determine if any significant differences exist in student computer use in clothing classes due to availability of computers, years of teaching experience, and type of computer training; determine if any significant differences exist between the teachers' rating of computer use and current use of computer; identify factors teachers perceived as influencing computer use; and identify needs perceived by teachers for implementing effective computer aided instruction in clothing and textiles programs.

Specific objectives were:

1. Identify types of computers and their availability for use by home economics teachers and students in the state of Arkansas.
2. Identify the average time of computer use by high school students in clothing and textiles classes of home economics.
3. Rank the hours of student computer use according to the six cothing and textiles subject areas.
4. Identify courseware high school teachers have found most helpful for teaching clothing and textiles course in Arkansas secondary home economics programs.
5. Determine if any significant differences exist in hours of student computer use in clothing and textiles classes due to availability of computers, years of teaching experience and type of computer training.
6. Determine if any significant differences exist between teachers' rating for the suitability of the computer as an effective tool for clothing subject areas and those in which the computer is being used.
7. Identify selected factors teachers perceive as influencing computer aided instruction as a teaching tool for clothing and textiles.
8. To identify needs perceived by secondary teachers for effectively implementing computer aided instruction in secondary home economics clothing programs.

Data necessary to meet the objectives were collected by an instrument, Computer-Aided Clothing and Textiles Questionnaire, mailed to 200 randomly selected Arkansas home economics teachers. One hundred eighteen or 59% of the questionnaires were returned and used for the study.

A SAS ANOVA procedure using the Duncan's multiple range test was utilized for the statistical treatment of the data to determine significant differences among the varibles. Pearson Correlation Coefficient was used to test for relationships among variables. Also, mean, frequency distributions, and percentages were calculated.

Ninety three of the 118 respondents reported that their students had access to computers. Fifty seven (63%) have computers in their classroom. The remaining 37% have computers located in a central location or laboratory. The number of computers available for students use varied among high schools from 0 to 20. Approximately 55% of the schools have from 1-5 computers available for use by students for clothing instruction followed by 25% with 6-15 computers, 21% with 0, and 1% with 16 to 20 computers.

Types of computers available ranked in order of most frequently reported to least were Apples, Radio Shack, IBM, Commodore, MacIntosh, and Texas Instruments. A significantly greater correlation $(p<.03)$ was found for the MacIntosh and computer use in clothing and textiles instruction than for any other computer type.

No significant differences were found regarding student computer use due to number of years teaching experience or type of computer training of the teacher. A significantly greater use of computers by student was found (ANOVA $p<.053$) with computers located in the classroom than for those in a central laboratory. Student use of computers located in the classroom averaged 2.57 hours per semester as compared to 0.26 for those located in a central location.

A significant difference $(p<.02)$ was found between the teachers' rating of the suitability of the computer as a teaching tool for clothing areas and those for which current use was reported. Teachers' rating of suitability of the computer as an effective teaching tool in clothing areas ranked from most to least as careers in clothing and textiles, clothing selection, textiles, care of clothing, economy of clothing and clothing construction. Hours of computer use reported for the clothing areas form most to least were construction, care of clothing, clothing selection, careers in clothing and textiles, textiles, and economy in clothing and textiles.

Eight respondents listed courseware they had found helpful in the teaching of clothing and textiles. Ideal Silhouette was listed by two respondents as a helpful teaching tool. Four respondents listed courseware on the subject of clothing construction.

More software was perceived by home economics teachers as being their greatest need for implementing computer aided instruction in clothing classes. This was followed by projector for computer screen, information for integrating computers, teacher training in computers, more hardware, evaluations of pertinent software and available resource people.

## Conclusions

Based on the findings of this study, computers are available for student use for the study of clothing and textiles in approximately four-fifths of the high schools in Arkansas. Approximately one-third of the home economics teachers with access to computer use it as a teaching tool for clothing and textiles subject areas. The average amount of student use in clothing instruction is approximately one hour and fifteen minutes per semester. The computer has been used as a tool by home economics teachers for all subject areas of clothing and textiles. Software appropriate to the clothing subject area is the greatest perceived need of high school home economics teachers for inplementing computer aided instruction in their clothing programs.

The MacIntosh computer located in the home economics classroom provides the most desirable situation for computer use in clothing and textiles classes. The study supports the need for suggested computer use in the clothing and textiles curriculum guide currently being written by the Vocational Technical Division of the Arkansas Department of Education.

## Implications

Implications of the study are that a need exists for appropriate software for secondary clothing and textiles instruction. This may indicate that greater communication between producers and teachers could result in writing more appropriate software for classroom use. Further study in evaluation of software and the perceived need of teachers could be helpful. The computer may not be the most effective teaching tool for all clothing and textiles subjects. Further study to identify the subjects most suitable for computer use could provide information essential for creating needed software and the use of computers as an effective tool in secondary home economics programs in Arkansas.

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# COMPUTER COURSES FOR PRESERVICE AND INSERVICE HOME ECONOMICS EDUCATORS

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## ABSTRACT

The majority of undergraduate and graduate students in home economics education are required to take computer courses or learn computer concepts in home economics methods classes. However, most of the required computer courses are taught by faculty members outside of the home economics education field. Approximately three-fourths of home economics education faculty teach computer concepts in methods courses.

Concepts most often included in graduate and undergradate computer courses were types of software, integrating home economics software into the curriculum, and word processing. Assignments and evaluation tools most frequently used in graduate and undergraduate courses include software evaluation, projects designed for use in home economics classrooms and tests or quizzes.

Apple IIe computers were most commonly used and preferred for computer courses.

## COMPUTER COURSES FOR HOME ECONOMICS
### THOMPSON AND SHIMOMURA

Computers have become an increasing part of our lives since the early seventies. The computer has evolved from a large mainframe that filled an entire room to a lap top portable unit. In 1985, computers were used in 97.8% of elementary and secondary schools (Statistical Abstract of the U.S., 1987). The prevelence of computers in the educational system prompted this study which investigated the preparation of home economics educators throughout the nation.

Professional educators must meet the challeges of today's technology by becoming computer literate. Computer literate teachers will facilitate the education of today's youth. The definition of computer literacy has transformed over the years.

Computer literacy during the 1970's was defined as the ability to write programs in COBOL, FORTRAN, or BASIC. In 1981, literacy was considered the ability to operate a key punch machine, process a stack of data cards and communicate with a mainframe computer. In 1982, literacy was defined as the ability to operate computers and use software, comprehend robotics and problem solve via the use of computer programing and simulations (Malpiedi, 1989). Pickert and Hunter (1983) stated that computer literacy included the ability for procedural thinking (identify and sequence procedures to achieve a specific task), communicating with written symbols through the means of a computer, and being competent in computer skills (whatever they may be). In addition to Pickert and Hunter's (1983) definition, Longstreet and Sorant (1985) emphasized the importance of adapting to present knowledge to new technology.

Troutner (1985) developed eight concepts of computer literacy: 1) having a general knowledge of the historical background and development of computers; 2) being familiar with correct computer vocabulary; 3) being able to describe the characteristics, uses, benefits and limitations of computers; 4) having an awareness of the current and projected impact of computer technology on society and the ethical issues involving computers; 5) knowing the location and meaning of keys on the computer keyboard; 6) learning to interact with a computer and acquiring a general understanding of how a computer operates; 7) developing problem-solving and decision-making skills through interaction with computers; and 8) learning to write simple programs in at least one computer language. Troutner's definition realizes that people who are computer literate do not have to be programmers, but users of information. Since educators are dispensers of information, they should be computer literate.

Computer literacy is valuable because the computer has two major uses for the teacher. The first is computer-managed instruction (CMI). CMI allows the teacher to create instructional materials and manage student data, such as grades. The second use is computer-aided instruction (CAI). CAI enhances the teaching and learning process through tutorials, simulations, and games.

Computer technology reaches all facets of education and life, increasing the need for teachers to effectively use the computer. In order for teachers to feel comfortable with computers, they need to be trained through inservice or preservice education.

"Preservice education must take students into various practical applications of the computer, software and hardware evaluation, and methods for teaching computer applications to others (especially methods that develop high-order thinking skills)" (Malpiedi, 1989). A number of teachers need to become familiar with CAD/CAM courses, the uses of robotics, and programming.

Inservice activities need to be sufficient time for teachers to learn computer concepts. Malpiedi (1989) reported that graduate courses, extended workshops, and preservice classes were the most successful methods used to update teachers.

According to Malpiedi (1989), "institutions must deliver whatever computer education is necessary, but that does not mean that every place needs to teach everything." Computers are innovative tools for student instruction and teacher utility programs, but they are not a replacement for classroom instruction.

Stafford (1989) cited that "schools are investing money for computers but very few dollars are spent on training teachers. For the most part, teachers are on their own when learning computer skills.

The microcomputer has become instrumental to classroom instruction. Many states are requiring educators to have basic knowledge of microcomputer use.

The purpose of this study was to determine the content of computer courses offered to undergraduate and graduate home economics educators. Surveys were sent to 167 universities and colleges nationwide. One hundred thirty-one (78%) questionnaires were returned. Fifty-nine (35.3%) universities indicated they did not require any computer training in the preservice or inservice home economics education program. One hundred eight (64.7%) questionnaires were analyzed to determine the computer content required of home economics educators.

Twenty-five (23.1%) of the respondants requiring computer courses indicated that computer courses offered to home economics education majors are taught by home economics education faculty members. Seventy two (66.7%) universities required home economics education students to take computer courses offered in other departments. Other departments included education, computer science, math, business, English, engineering, and psychology.

Some course titles used by home economics education faculty members include Microcomputers in Home Economics Education; Microcomputer Applications in Home Economics; Learning Systems Design; Materials, Methods, and Information Technology in Home Economics; and Technology in the Home.

Seventy-eight (73.6%) of the respondants indicated that home economics education faculty members teach computer concepts in home economics education courses. This indicates that although home economics education students may not be required to take a computer course, many are taught computer concepts in home economics methods courses.

The concepts most frequently included in undergraduate courses were types of software, integrating home economics software into the curriculum, word processing, types of hardware and use of graphics programs such printshop. Concepts most frequently included in graduate courses were types of software, integrating home economics software into the curriculum, use of graphics programs such as printshop, use of data base, and word processing.

Concepts least taught at the undergraduate level were use of modem, history of computers, use of spreadsheets, grading programs, and use of data base. At the graduate level, the concepts least frequently taught were history of computers, use of modem, computer hardware, use of spreadsheet, and grading programs.

Classroom assignments and evaluation tools most frequently used in the undergraduate and graduate courses include software evaluation, projects designed for use in home economics classrooms, tests or quizzes, reading assignments, and research projects with library references.

Assignments and evaluation tools used most frequently in undergraduate courses included software evaluation, projects designed for use in the home economics classrooms, tests or quizzes, reading assignments and research projects with library references. Graduate courses required software evaluation most frequently, followed by projects designed for use in home economics classrooms, research projects with library references, tests or quizzes, and reading assignments.

Apple IIe computers were used most frequently for computer courses, followed by IBM PC or IBM compatible without hard disk, IBM or IBM compatible with hard disk, and MacIntosh. Respondant indicated they would prefer to use Apple IIe, followed by IBM or IBM compatible with hard disk, MacIntosh, and IBM PC or IBM compatible without hard disk.

The mean percentage of course time spent on hands-on computer intruction was 30.48%. The mode percentage of hand-on instruction was 10%.

Seventy-eight percent of the respondants indicated that computers were used by students both during and outside of classtime.

## CONCLUSIONS

Questionnaires were mailed to 167 universities with home economics education programs to determine the extent of computer training in undergraduate and graduate home economics education programs. One hundred thirty-one questionnaires were returned. One hundred eight universities indicated that computer concepts are taught in courses taught in other departments (66.7%) or by home economics education faculty members (23.1%). In addition, many respondants (73.6%) indicated that home economics education faculty members teach computer concepts in methods courses.

Concepts most frequently included in computer courses included types of software, integrating home economics software into the curriculum, and word processing. Apple IIE computers were most commonly used by respondants.

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# CRITIQUE OF FINANCIAL PLANNING SOFTWARE AS AN EDUCATIONAL TOOL IN FAMILY ECONOMICS AND PERSONAL FINANCIAL ADVISING/PLANNING

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## ABSTRACT

The critique and use of financial planning computer programs from a family economics perspective provide a multidisciplinary approach. Harmful, incomplete and inaccurate information may be transmitted by a computer generated plan or calculations without this perspective. Results of an analysis of the educational use of financial planning software imply that students who learn to critique programs from the family economics perspective are educated to provide a challenging service in the creative use of resources for clients' economic well-being.

## INTRODUCTION

Family economists and their financial planning students need both theoretical background and technical knowledge to evaluate computer programs in identifying issues, assumptions, questions, and appropriateness for various clientele. The critique of financial planning software from a family economics perspective is different than that from a business perspective, although the criteria for both are proposed in this study. The critique of financial planning software as an instructional tool for students in their preparation for the financial planning profession is different than that of the practitioner. Differences occur in the purposes of computer use, the setting, and the breadth or depth, as will be shown.

The professional judgement required at the evaluation level in the critique of financial planning software from the family economics perspective is based on the knowledge, understanding, application, analysis and synthesis levels of these concepts: family resource management, decision making at various stages of the family life cycle, wealth accumulation, complex family systems, behavior modification, tax policies, time value of money, and indicators of the economic/business environment. Personal financial advising or financial planning requires complex judgement based on the interrelatedness of these concepts. Professional judgement based on these concepts in applying theories and techniques to improve personal or household economic well-being and security will consider the creative use of all resources, not just financial.

Preparation for the career in financial planning includes understanding and skills in computer assistance as stated in promotional material:

> In addition to financial planning courses, a computer course is becoming more and more essential. Most financial planners consider the computer an integral part of their practice, particularly for word processing, data management, and graphic applications. The planning function is dependent upon being able to collect, store, manipulate and update information and then share this information with clients. Financial planning software available today enables planners to improve their productivity and service to their clients; of course in or itself financial planning software is not a substitute for sound independent analysis by the planner (Kelly, 1989, 4).

## FAMILY ECONOMICS

The contributions unique to the family economics perspective in contrast to the usual business perspective include the following:

1. Ability to adapt computer software programs to the realities of how family members interact, react, make decisions and handle stress and risk.
2. Insight into the real needs and issues of clients underlying their requests for financial planning.
3. Generation of creative alternatives in problem solving with the utilization of all types of resources including non-financial and change of attitudes and behavior.
4. Knowledge to address the individuality and complexity of persons or households.
5. Application of a telescopic vision in making decisions with the outlook of changes at various stages of the life cycle and of the economic/business environment.
6. Realization of the importance to clarify and rank wants/values in order to obtain them sequentially.
7. Wisdom to maintain a balance among past, present, and future; among all types of basic needs; among concerns for self and for others, and between human and monetary capital.
8. Application of family resource management steps to life circumstances and decisions.
9. Utilization of systems theory and the eco-systems approach.
10. Understanding of various management styles and personality complexes which direct effective means for helping clients to implement plans.

Hathaway proposed that:

> The principal use of microcomputers in the area of family financial management and decision-making is for the many technical decisions in allocating economic resources. Increasingly, effective family decision-making about household consumption and production activities will require efficient evaluation of complex information related to competing alternatives. The decisions about investing in physical or human capital by families are cumulative in their effects and not easily reversible in many cases. The microcomputer has the potential to permit them to select alternatives whose overall path bring them closer to an optimum quality of life than may be the case of simple incremental decision-making (Hathaway, 1985, 42).

## FINANCIAL PLANNING

The contribution of financial planning software in making decisions and projecting outcomes with various assumptions has provided an application of family economics and resource management disciplines, an astuteness and quantification of individualized plans, and graphic results of decisions. Computer analysis and projection combined with the professional judgement of a family economist will reduce the risk in decisions and maximize family resources. Family resource management processes are evident in the process of financial planning (Staff, 1984):

1. Clarify present situation through collecting and assessing all relevant financial data such as lists of assets and liabilities, tax returns, records of securities transactions, insurance policies.
2. Decide direction by identifying both financial and personal goals and objectives. The financial planning practitioner helps you clarify financial and personal values and attitudes. These may include providing for your children's college education, supporting elderly parents or relieving immediate financial pressures which would help maintain your current lifestyle and provide for retirement. These considerations are as important as what's in your bank account in determining the best financial planning strategy for you.
3. Identify financial problems which create barriers to financial independence. Problem areas can include too little or too much insurance coverage or a high tax burden. Your cash flow may be inadequate, or your current investments may not be winning the battle with inflation. These possible problem areas must be identified before solutions can be found.
4. Provide written recommendations and alternative solutions. The length of the recommendations will vary with the complexity of your individual situation, but they always should be structured to meet your needs without emphasis on purchasing certain investment products.

5. Implement of coordinate the implementation of the right strategy to assure that you reach your goals and objectives. A financial plan is only helpful if the recommendations are put into action. The practitioner should assist you either in actually implementing the recommendations or in coordinating the implementation with other knowledgeable professionals.
6. Provide periodic review and revision of your plan to assure that you achieve your goals. You should have your financial situation re-assessed at least once a year to account for changes in your life and current economic conditions (Staff, 1984, 3-6).

## ISSUES

Knowledge of the client, purposes involved, and various computer software available is necessary for selecting the appropriate software. Results of current surveys and critiques are available from family economists and resource management specialists (Hathaway, 1989). The variety of computer programs include simple calculations, time-value calculations for adjusting for inflation, tax rate and projections, record-keeping, basic budgeting, accounting, mini-financial plans, comprehensive financial plans, plans with graphics and texts. One of the first issues is whether the client needs a "mini-plan" or a comprehensive plan. A client may only need facts for a single decision.

Potential computer applications for financial planning/advising/counseling include: diagnosis, data storage and retrieval, and decision algorithms (Helmick, 1983). Utility software according to Helmick (1983) are: spreadsheets, equation solver, data base management, and time value calculation. Potential applications in problem solving include planning a debt repayment schedule and cash flow analysis. Financial record keeping and analysis for home use include expenditure records, budget analysis, check reconciliation, check printing, financial statements, tax records and form preparation, and portfolio analysis. Educational programs for clientele include cost of borrowing, reaching one's savings goals, life insurance planning, budgeting for necessities, estimating the costs of owning and operating a vehicle, and simulation (Helmick, 1983).

Graphics may illustrate portions of payments for interest. Total interest paid monthly, shown graphically, may change behavior more than words.

The second issue involves selection of appropriate assumptions which are selected and critiqued based on historic information and economic theory. The areas in which assumptions must be examined and a decision made are life expectancy, inflation rate, productivity rate, investment return, tax rate and policy, divorce rate, employment security, value of housing, and risk tolerance.

The academic background required of students for the critique and use of software is another issue. The skills and knowledge required would direct the curriculum design so that competencies are developed for professional judgement in advising clients on critique of software.

An educational issue is the extent to which students should use formulas and worksheets to solve problems and make plans before critiquing software. An educated person needs practice and study beyond what is used with clients or in a particular job position in order to make the professional judgements about assumptions, appropriateness, and validity of commercially prepared computer plans.

## CRITERIA FOR CRITIQUE OF SOFTWARE

A standardized list of components and characteristics used in the critique of software has emerged from review of the literature in the field of financial planning. Selection criteria used by Gustafson (1987, 35) were "integrated versus stand-alone packages; compatibility; adaptability and add-ons; online assistance such as pop-up menus and tutorials; documentation; educator assistance; learning curve; and user satisfaction and ease of use ratings."

Practitioners can use "a disciplined methodology for matching practice and client need" (Bevington 1987, 93). Practitioners need flexibility and customization. Practitioners should have the features and financial tasks "appropriate for different levels of practice, sophistication, and size [of firm]" (93). The assumptions that are built into the program need to be available.

Questions have been developed (Bevington, 1987, 93) "to provide a solid methodology for determining software needs, evaluating integrated financial planning software and matching software needs with the appropriate product". The outline adapted and quoted by permission (Bevington, 1987) follows:

I. A. Quantifying Software Needs
    1. Client Market - Stability, Income Asset Mix, Retention
        a. Current Year
        b. Projected Year

  2. Planning Style - Single Issue/"Mini"/Comprehensive Planning
     a. Current
     b. Projected
  3. Practice Economics
     a. Current
     b. Projected (depends in large part on software chosen)

B. Types of Integrated Financial Planning Software
  1. Non-Decision-Making
  2. Basic Decision-Making
  3. Integrated Decision-Making (integrated decision within an integrated system)

C. Determining When a Practice Needs Integrated System
  1. Number of Plans Per Year
  2. Profit or Loss on Per-Plan Basis

D. Choosing the Appropriate Software Category for Current and Future Practice Needs
  1. Rules-Of-Thumb, Based on How You Have Quantified Needs (see A)
  2. Using Outside Experts

E. Narrowing the Search of Products and Companies
  1. Directories
  2. Financial Planning Software Consultants
  3. Other Planners
  4. Sales Literature

F. Getting Information about a few Products and Companies
  1. Sales Representatives (see questions below)
  2. Technical Experts within the Company
  3. Consultants
  4. Other Planners (see checklist)
  5. Company Information and Documents (see questions below)

G. Matching Integrated Financial Planning Software Needs with the Appropriate Product (see questions below)
  1. Service and Training
  2. Technology
  3. Output
  4. Input
  5. Corporate Background

H. Calculating the Economics of Purchasing a Particular Software Product
  1. Revenues
     a. Fees
     b. Commissions
  2. Costs
     a. Actual software/hardware (expense and depreciation)
     b. Personnel
     c. Training
     d. Maintenance
     e. "Getting up to speed" time

II. A. Questions to Ask a Sales Representative
  1. Do you provide initial training? Where are classes held, how much do they cost, and how long do they last?
  2. Do you provide advanced training for enhancements,etc.?
  3. How many hours or days will it take for me, given my computer background, to get up to speed on your system?
  4. Do you provide different levels of training for different functions (data entry, actual planning, etc.)?
  5. What does the annual maintenance fee include?
  6. Are all anticipated future enhancements included in this fee?
  7. What enhancements do you have planned for the next 12 months?
  8. Do you provide financial planning support as well as technical support?

B. Technology Questions to ask Company Technical Experts
  1. What is the language your program is written in?
  2. What hardware (including disk space) do I need to run your program?
  3. What other software do I need to run your program?
  4. What hardware/software is included in your program, and what is available at extra cost?
  5. Is this system decision-making? If so, how many rules (heuristics) does it employ?
  6. (If decision making) Can I change some/most/all of these heuristics?
  7. (If decision making) Where did your company come up with these rules-of-thumb?
  8. (If decision making) Where did your company come up with these rules-of-thumb?
  9. (If decision making) What attitudes/goals does the system take into account when making decisions?

C. Output Questions to ask Representatives
  1. How many pages is the longest plan? The shortest?
  2. Can a "mini plan" be generated?

3. Can a single-issue (e.g., education, retirement) report be generated?
4. How many years in the future will the reports project? Can a planner change the number of years?
5. Are the Federal and State income tax calculations accurate or are they estimates?
6. How many schedules are there in each section?
7. Which schedules can be graphed?
8. Can the schedules and/or text be modified with a word processor?
9. (If a non-decision-making system) Is there a text library? Who wrote it?
10. What auxiliary reports are available (data entry verification, summary plan for planner, client management reports, etc.)?
11. Can output be printed to a disk file?
12. How does the system handle "what-if"? Is there a built-in spreadsheet, and what does the output look like?

D. Input Questions to ask Representatives
  1. Who is your questionnaire designed for?
  2. Is required information highlighted in some way in the questionnaire and/or at data entry?
  3. Can someone without financial planning knowledge input the data?
  4. Do the data entry screens look like the factfinder? Are fields numbered or coded?
  5. What kind of error trapping is built into data entry?
  6. Are there help screens for data entry?

E. Corporate Background
  1. Who founded your company and why?
  2. When did your company start selling software?
  3. How many employees are there?
  4. How many software products do you sell? Are they all financial-planning related?
  5. Where can I get financial information about your company and where has your financial backing come from?
  6. Is your company a subsidiary of or affiliated with any other company?
  7. Where did the financial expertise in your system come from?
  8. Who do you consider to be your main software competitors?
  9. Why is your product better than your competitors'?

F. The Nitty Gritty
  1. How much does the software cost and is there a full refund period?
  2. Do you sell the hardware also? How much?
  3. How much is the annual maintenance?
  4. Do you expect the software, hardware, or maintenance costs to change in the next year?
  5. Can you give me the names of three planners with practices similar to mine who would be willing to talk to me?
  6. Review the following items:
     1. a completed factfinder
     2. a sample plan based on the completed factfinder
     3. all schedules
     4. all auxiliary reports, including client management reports
     5. all graphs
     6. text library (if non-decision-making)
     7. information about your company
     8. sales literature
     9. technical explanations
     10. sample software licensing agreement

III. A. Planner/Practice Background to Ask of Software Users
  1. How long have you been a financial planner?
  2. What is your background?
  3. Who is your target market (income/assets/age)?
  4. How are you compensated?
  5. How many plans do you expect to do this year? Next year?
  6. How much do you charge, on average, for a comprehensive financial plan?
  7. How much commission do you generate on average?
  8. How much do you charge for an annual update?
  9. What is your hardware configuration?
  10. When did you buy this software and how much did you pay?

B. Plan Generation
  11. Who completes the questionnaire (client, client and paraplanner, client and planner, etc.)?

C. Who Performs Each of These Functions, and How Long Does It Take, on Average?
    - Function
    - Input Data
    - Evaluate Spreadsheets
    - Preliminary Recommendations
    - Analyze Spreadsheets
    - Final Recommendations
    - Write Plan
    - Edit Plan

D. Service and Training of Software User
    - 13. How long did it take you to get "up to speed" on the system (a. before you ran your first plan; b. before you ran plans routinely)?
    - 14. If you had software sponsored training, was it worthwhile?
    - 15. Did you purchase a maintenance contract?
    - 16. How quickly does the company respond to your software questions and problems, tax law changes, etc.?

E. Overall Evaluation to Ask of Software User
    - 17. What features do you like and/or use the most?
    - 18. What features do you like and/or use the least?
    - 19. If you had to do it over again, would you buy this system?
    - 20. Should I buy this system?

IV. A. Service and Training in Critiquing Software
    - 1. Can I expect to receive the ongoing service I need?
        - a. Are updates timely?
        - b. Are future enhancements planned?
        - c. Is customer response fast enough for my practice?
        - d. Could bugs be a major problem in the future?
        - e. Are enough company resources committed to service?
    - 2. In the long run, is the training adequate?
        - a. Will I get adequate initial training?
        - b. Does the expected "getting up to speed" time seem too long given the level of complexity of the system?
        - c. Is the ongoing training offered adequate?
        - d. On this system, who could perform these functions:
            - 1. data entry
            - 2. plan generation
            - 3. plan review and editing
            - 4. client management
        - e. Does this division of labor make sense in my practice?

B. Technology in Critiquing Software
    - 1. Can the underlying technology be built-upon, or is it likely to become obsolete in a few years?
    - 2. Will I need more hardware; if so, will this hardware be useful for other office functions as well?
    - 3. What optional software will I want to purchase along with the main system?
    - 4. Is a Client Management System available? If so, can it become the "central nervous system" of my practice (client asset/liability information, account activity, billing and income tracking, mail merge)?
    - 5. Is this system so simple that I will outgrow it in two years?
    - 6. Is this system so complex that I will give up before it becomes an established part of this practice?

C. Output in Critiquing Software
    - 1. Do I need single-issue capability?
    - 2. Do I need "mini-plan" capability?
    - 3. Is the sample plan well organized and visually appealing?
    - 4. Is it too intimidating or too basic for (a) current clientele? (b) future clientele?
    - 5. Do I understand almost everything in the plan after a few read-throughs
    - 6. Does it appear too "computer generated" or not "computery" enough?
    - 7. Is the text awkward or condescending?
    - 8. Is the text informative enough? Is it too detailed?
    - 9. Are the client's goals and attitudes (if appropriate) restated prominently throughout the plan?
    - 10. Are the graphs easily understandable?
    - 11. Is there a summary of recommendations?
    - 12. Complete values and adequacy for possible usable and summary schedules:
        - Area
        - Tax
        - Investment
        - Retirement
        - Risk
        - Estate

Cash/Credit
Education
Other Goals

D. Input: The Factfinder
1. Is it well organized and visually appealing
2. Is it too intimidating or too basic for (a) current clientele? (b) clientele in future years?
3. Do I understand everything on it after a few read-throughs?
4. Who on my current or anticipated staff will assist in completing and reviewing the factfinder?
5. Does it need directions? If so, does it include adequate directions?
6. Is the level of information required suitable for (a) current clientele? (b) clientele in future years?
7. Do I feel comfortable with the way subjective questions are phrased?
8. How long will it take to complete the factfinding process?

E. Input: Data Entry and Plan Generation
1. Can I expect data entry to be a fairly smooth process?
2. How long will the data entry process take?
3. Who will perform each of these functions and how long will it take?
   Input Data
   Evaluate Spreadsheets
   Preliminary Recommendations
   Analyze Spreadsheets
   Final Recommendations
   Write Plan
   Edit Plan

F. Company Background
1. Have I checked at least two independent sources to determine the company's viability long-term?
2. Is the company keeping up with financial planning and technological trends?
3. Does the company have a good track record?
4. Does it seem stronger overall than its main competitors?
5. Do I respect the company's sources of financial planning expertise?

G. The Nitty Gritty
1. How much more profitable will the system make my practice in the long run?
2. Can I afford the system from a cash flow stand point until I start to break even?
3. Does the image this system projects match the image I want my clients to have of me?

H. Evaluation of Basic Decision-Making Systems
1. Are the number and type of rules-of-thumb (heuristics) adequate for my practice needs?
2. Can I eliminate those heuristics I don't like?
3. Can I modify the heuristics?
4. Can I add my own rules-of-thumb?
5. Is it easy to find out from the system why a particular recommendation was made?
6. Can "what-if" by changing the rules-of thumb?
7. Are any rules of thumb based on qualitative information?

I. Evaluation of Integrated Decision-Making Systems
1. Do I feel comfortable with the way trade-off's are made between competing objectives or rules-of-thumb?
2. Is the impact of recommendations on cash flow always modeled? Do I like the way it is modeled?
3. Does the system recommend generic products? Can I change generic products recommendations system-wide?
4. Are products selected which meet more than one recommendation?
5. Do I feel comfortable with the overall financial planning philosophy? (Adapted from Bevington, 1987)

## METHODS

The method used to critique software would include the issues, assumptions and questions when assessing individual software donated by firms either as a part of the capstone course in financial counseling and planning, a separate course in financial planning with computers, or as independent study.

Education objectives for a computer-based course or learning activity integrated into a course involve the cognitive, affective, and psycho-motor domains. The following is a proposed educational objective in the cognitive domain:

A student planning for a career in financial counseling and planning or a resource management specialist should be able to critique software by identifying the issues, the assumptions, needs of the client, capabilities of the software, mechanics of the computer program to change assumptions and "what-ifs", adaptation of printouts of computer analysis and projection to individuality of the client, the explanation and justification of the input and output, economic and family conditions or tax policies which would change recommendations.

Use of software begins with simple programs and advances to the more complex and comprehensive as time permits. Evidence of word processing and spreadsheets is required. The use of spreadsheets provides an appreciation of the complex financial planning computer programs.

A teaching assistant or graduating senior, as a special problem, has effectively supervised examinations on computer software after he/she has had a similar course at Purdue University. Mature students have operated independently as in a programmed learning package. Daily logs, checklists and short answer questions provide evidence that critique has occurred. Notes from readings are required. Reading material about use of computers is available from financial planning journals, software company newsletters, and PC Week and similar publications. Demonstration packages of software are viewed. Actual client cases or parents of students are utilized in the examination of software. Students working in teams can learn more than alone as they discuss issues and struggle with the mechanics of using the software. At the least, students should be able to use computers to address the "most common financial problems middle-income families face: children's future educational costs, the amount of needed retirement income, the amount of life insurance a family would need in the event of the death of a wage earner, and this year's and next year's state and federal income taxes" (Hume, 1988, 49). Net worth and cash flow statements should be typed in the standardized format with proper headings by using a spreadsheet program.

Students have reported that the critique and use of financial planning software is stimulating, provides opportunity to apply theories and tools used in previous courses, and is a confidence booster. Students rate the computer work as one of the most valuable components of their capstone course. Most software programs are educational in clarifying financial terms and developing computer skills.

Students will develop financial planning expertise as they examine explanatory texts and sample case studies provided by the computer software program. "An effective case-writing library" of text should be flexible enough to produce a definitely customized plan if desired" (Leonard, 1983, 219). "Screen modeling provides the ability to develop financial models on the screen, play 'what-if' games, and see the outcome before printing the hard copy" (Leonard, 1983, 219). Documentation manuals which provide sample data input are educational for students.

Students need to understand the mechanisms and formulas behind the models. Documentation and commands should be clear. Some software programs "allow the user to define relationships and variables with English words rather than awkward coding" (Faust, 82) and the data are not "couched in an obscure modeling language."

An educational program rather than a training program is justified by the statement, "A client depends more on the skill of the person using the program than on the software itself" (Hume, 1988, 54). Clients are advised to investigate the planner's background, his philosophy, his objectivity, and previous clients. "The service of the financial planner is more important than what software you use" (Hume, 54). "A planner must be realistic about the impossibility of projecting someone's finances 40 years into the future" (Hume, 54). Therefore, the educational program should include ethics and commitment to the well-being of clients.

## CONCLUSIONS AND IMPLICATIONS

The critique and use of computer software for financial advising/ planning from a family economic perspective apply both art and science in helping clients to improve their economic well-being. The practice is multi-disciplinary and a challenge to creative and critical thinking.

A computer printout with a financial plan that is not adapted nor integrated with the professional judgement utilizing family economics and resource management will not be implemented satisfactorily. Providing estimates of dollars needed for financing children's education, buying a house, or retirement will do more harm than good if alternative methods to provide for these wants are not presented. Rules utilized in computer programs can not be substituted for creative thinking by the professional or researcher. Financial advisors/planners consider the client's unique values, management style and other agendas if they are to be effective.

Financial planning software provides documentation and knowledge which will change behavior and support the advice given by the professional. A comparison of the economic status, taxes, return on monetary and human capital, and debt before and after planning will help to motivate clients to confront reality, change behavior, implement plans or use products, redirect assets, and increase a sense of control.

Curriculum in family economics, financial planning, financial counseling, or personal financial advising must include a critique of computer software to meet the objectives of these professions of helping families to improve decision-making, reduce risks, and maximize resources. The latest of the technology must be utilized in the critique to prepare students to compete in the marketplace for employment opportunities. For financial advising/planning to be recognized as a trusted and respectable profession, the theories and tools of family economics and resource management must be applied in the critique and use of financial planning software.

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# Professional CADD Staff Development :
# Considerations for Training Program Implementation

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## Abstract

This paper provides an overview to the process of developing an inhouse training program for computer-aided drafting and design (CADD) users. Many firms are willing to make large capital investments for CADD technology, while skimping on the cost of providing adequate training for operators, technicians, managers, and other users. Emphasis is placed on production, increased productivity and reduced design cycles without realizing that to achieve such improvements depends on the proper selection and training of the personnel who will operate it.

## Introduction

When a firm invests several hundreds of thousands of dollars for a CAD/CAM system you can be sure that its' not going to set idle. Engineering and design firms that integrate these new CAD/CAM technologies into their organizations find that they have little time to provide for the training of operating personnel. Management tends to place constraints on a system from the start. We are all aware of the emphasis placed on CAD/CAM in improving productivity and reducing product design cycles. What we must begin to consider inorder to achieve these goals, it that operating personnel requires many new skills.

Training involves more than just telling an individual what to do. Do not hand an individual a manual and expect them to become a proficient CAD/CAM user in a short period of time. An industrial training program must provide an individual with a series of well thought out exercises that develop their skills. Once developed, the program should provide additional training opportunities to maintain existing skills, overcome potential problems, and learn new techniques.

Training provides individuals with opportunities to grow careerwise. From a motivational aspect, a well trained individual is more likely to perform their duties at higher efficiency. Because they understand the capabilities of the system, one can expect higher productivity from a well trained individual. If opportunities for career growth are not provided through formal training, then one can expect to see system productivity peek and eventually show signs of decline.

## Adult Education

Training of CADD personnel should be conducted from an adult perspective. The same techniques used in educating children should not be applied to the adult. Innovative techniques should be included in the design of a program that takes advantage of the individuals learning capabilities. The program planner should be knowledgeable of some of the principles of adult education and how adults learn. Several excellent resources on the subject are available for review (Knowles, 1980) (Jarvis, 1987).

In recent years, there has been an increasing awareness of the differences in how new information is presented to the adult. Two terms are used to describe the difference between the education of children and that of adults. **Andragogy** is defined as 'the art and science of helping adults learn', and in contrast, **pedagogy** refers to 'the art and science of teaching children' (Knowles, 1980, p. 43). In defining the process of andragogy, Malcolm Knowles provides four assumptions describing the adult learner. These are :

> " . . . 1) their self-concept moves from one of being a dependent personality toward being a self-directed person; 2) they accumulate a growing reservoir of experience that becomes an increasing rich resource for learning; 3) their readiness to learn becomes oriented increasingly to the developmental tasks of their social roles; and 4) their time perspective changes from one of postponed application of knowledge to immediacy of application, and accordingly, their orientation toward learning shifts from one of subject-centered to one of performance-centeredness. . ."(Knowles, 1980 pp. 44-45)

To the adult, both learning environment and the delivery system ( how one introduces the information) plays an important role and to some extent determines the success of learning itself. Adults come into a learning situation with preconceived notions on what to expect, based upon previous experience. The have been conditioned by the pedagogical methodology through out their lifes. There perception of the learner is ". . . that of a dependent . . . more or less [a] passive recipient of transmitted content, that even though they may be completely self-directed in all other aspects of their lives, the minute they enter into any activity labeled "education", they set back, fold their arms, and say "teach me." . . .(Knowles, p. 50).

A CADD training program should incorporate the use of demonstration, skill-practice exercises, and practical application. The use of lecture and written materials should be kept to a minimum and increased use of participatory techniques should be utilized. The use of problem-centered materials and techniques fit into the adult learning process very well. Since learning is an internal process, then self-directed approaches will encourage individual learning.

Classroom environment plays a major role in encouraging learning. A facility for teaching need not be in the form of a standard classroom. It should incorporate new technologies that assists the instructor or encourage self-learning by the trainee. The classroom facility for a CADD training program should utilize video projection, interactive video technology, and the use of other multi-media methods that encourage "multi-channel" learning.

## CAD Training Program Development

There are many methodologies described in literature from which a program planner may choose (Boone, 1985) (Sork, 1986). These approaches are classified as classical, systems, and political. Each has its' place in implementing a new program. Some methodologies are more acceptable than others due to their radical context and approach.

Many excellent features exist in each approach, yet not any one approach on its' own merit can be said to be the best or correct way to develop a program.

Which modeling method to select from depends upon the individual situation at hand. The program designer must evaluate the existing environment and determine which approach is best suited for developing and implementing the program. In many instances, it is appropriate to borrow certain aspects from each modeling technique that best suite the existing situation. More than likely, classical and systems modeling will provide the planner with the best approach.

In classical modeling, a systematic approach to defining a means to achieve a goal or set of objectives is followed. An examination of any literature describing classical modeling will quickly reveal a common set of events or processes that are followed. Typically the following steps are found to some extent within various classical approaches :

1. **Identify the need.**
2. **Define the objectives of the program.**
3. **Determine any specific constraints.**
4. **Identify alternative solutions or approachs.**
5. **Analyze solution in terms of direction**
6. **Implement the solution.**
7. **Review operations of the program.**
8. **Correct or modify program if weakness is identified.**

Systems modeling looks at the infrastructure of the framework of an organization and what impacts a program may have on that structure when implemented. The key to this process involves gaining an understanding of the structure of the systems and the various sub-systems that make up the entire framework. A program designer must take into consideration the following points when designing a new program:

1. **Analyze the structure of the organization.**
2. **Determine the scope of the inter-relations between sub-groups defining the system.**
3. **Identify the political structures within the system.**
4. **Identify the structural and political barriers that are inherent to the system/organization.**
5. **Define program objectives and establish realistic management objectives.**
6. **Define expected outputs of the program and how they relate to the sub-group and eventually the group.**

Political modeling involves points and concepts that differ greatly from classical and systems approachs. While classical and systems are ideal for handling training and educational programs at various levels, group size or topics, the political approach takes on radical tones. Political modeling involves the raising of individuals own conscience and cultural outlooks by giving them the resources to question conditions that they may exist in (Elias, 1984). For all purposes, this methodolgy is beyond the scope of this presentation and will not be discussed.

One methodology that is benificial to program planners is the Training Technology System (TTS) (Swanson, 1987). This program is a systematic approach to the development and management of training programs within business and industry. Five phases make up the TTS approach, these consisting of:

**(1) Analyze,**
**(2) Design,**
**(3) Develop,**
**(4) Implement, and**
**(5) Control.**

This particular methodology is broad in nature, covering organizational needs assessment and the economic impact of training.

Industrial training programs are well suited for a combination of the classical and systems modeling approach as a means of program design and implementation. Caffarella (1988) stresses the importance of using modelling in the design and development of training programs. She lists four major reasons why staff involved in training program development fail to use a model. These are "1.) Time pressure, 2.) Organizational environment, 3.) lack of knowledge about available models, and 4.) Rejection of models as too confining to be helpful". The program designer must work with clearly defined facts and requirements as established by management and corporate policies. Outcome of the program must be predictable and closely monitored to insure management that the results of the program meet expectations. Means of meeting rapid change in a corporation are essential to the training program and it must be able to keep pace with the demands placed upon it. Modeling staff development programs represents an efficient approach to implementing high technology within an organization.

## CAD Training Program Development

The CAD program planner will find that many of the objectives and needs of the program have been predefined by management objective. Since guidelines are relatively fixed, requiring the program planner to look at solutions and approaches that work within the constraints of the corporate system. It is in this context, that the planner should be aware of the fundamental concepts that lie within classical and systems methodologies previously discussed. In defining a program that fits into this corporate frame work, sufficient leeway is provided by many top line managers as the the day-to-day function of the program- *as long as the result may be quantified.*

## Cost and Time Constraints

Several predefined constraints exist in developing a new training program within industry. First, the bottom line is cost. Any program must be developed, implemented and ran as efficiently as possible for the least amount of money. Secondly, constraints are placed on the amount of time allocated to train employees. On-the-job training is often preferred over classroom time where possible. Efforts should be made to maximize the amount of time required to learn a new task(s), with the least disruption on operations is imperative.

## Objectives of CAD/CAM Training

An industrial CAD/CAM training program must be prepared to take up from where vendor programs leave off. Such training must incorporate objectives that go far beyond those of vendor training. In-house training must be flexible and take into consideration several key factors. In determining program objectives, an analysis of how the system will be utilized and by whom must be undertaken. Below are five key questions that should be addressed as part of the process of establishing program objectives.

**Is the system production oriented (i.e., drafting) or is it design oriented (i.e., engineering / analysis)?**

**Are the users to be dedicated or causal, technicians or engineers?**

**Do you have a centralized or decentralized structure?**

**Is the system mainframe, super-mini, mini, or micro based?**

**Are you running single or mutiple shifts?**

## The Cost of Implementing CAD Training

How much does it cost to train CAD personnel? That question has been asked by many individuals who have the responsibility for the development of training programs. Efforts have been made to place a dollar value on that cost through various approachs. Most approachs take into consideration quantitative variables, the *tangible* factors. There are however certian aspects that are difficult to assign a monetary value to, these are ofter refered to as *intangible* factors.

Training can be divided into two levels. The first is that of the new user. This individual probably had little or no exposure to the computer. The emphasis on introducing the employee to new skills and how to utilize the system is vital. A training program must address such personnel inorder to make them feel confortable with the technology. Productivity improvements may be achieved through individuals gaining an understanding of how to use CADD efficently as a new tool.

The second level of training involves that of updating and maintaining the skills of CADD users already utilizing the technology. Providing the users with new skills makes it possible for them to maintain their productivity. As softwares are updated or new applications added, these individuals should receive additional training inorder to maintain their skills level. Improved productivity is best achieved if the user understands the full capability of the tools they are utilizing.

There are four fundamental factors to which quanitative costs may be assigned. One must take into account the cost of both hardware and software and the cost of personnel, or *humanware*. These costs are readily available as the result of a cost/benefit study of the CAD system and may be applied to calcuating the costs of training personnel. These factors are :

1. **Trainee Cost per hour.**
2. **Trainer Cost per hour.**
3. **Workstation Cost per hour.**
4. **Training program development cost.**

The forth cost factor is not initially available, but represents an important contributing factor consisting of training materials. Many times this does not appear included in determining actual training costs. Training materials must either be custom developed or purchased. The availability of well prepared and efficient audio/visual materials is essential for a successful training program. This expense should be factored into the calculation of training costs for in-house training programs.

The cost of operator education may be calculated by using the following set of equations. This methodology does incorporate a chargeback for development, maintenance and reproduction of training materials. Table 1 lists the variables that should be considered in determine the training costs for CADD operators.

| Variable Description | Variable | Inputs |
|---|---|---|
| Cost of workstation per hour | $C_w$ | $30.00 |
| Number of CAD workstations | $N_w$ | 1 |
| Hourly cost of trainee | $C_t$ | $18.00 |
| Number of trainees | $N_t$ | 8 |
| Hourly cost of instructor | $C_i$ | $25.00 |
| Hours required for training | $H_t$ | 232 |
| Instructor availablity factor | $I_a$ | .5 |
| Workstation logon factor | $W_t$ $(I_a + W_t = 1)$ | .5 |
| Number of instructors | $N_i$ | 1 |
| Number of training sessions | $N_s$ | 1 |
| Development cost of handouts | $C_h$ | $200.00 |

**TABLE 1**
*Training Calculation Variables*

Trainer time (Ia) is factored into the calculations to represent the percentage of time available for lecture / demonstration ( i.e., .50 indicates half the time is reserved for presentation of material, and the remaining time is reserved for hands on sessions). Thus logon and instructor time must be equal to 1 (Ia + Wt ). The equations for calculation of total cost of one trainee (TCt ), total workstation cost for sessions (TCw ), total cost for instructor (TCi ), and reproduction cost of handouts (TCh) are shown in Figure 1.

Based on a modular training approach that provides entry, intermediate and advanced education sessions at user, applications specialist (programmer) and management levels, the dedicated user will spend approximately 232 hours in training classes during the first year-and-a-half. Workstation cost per hour may be extracted from cost-benefit analysis conducted as part of the system justification process. Actual workstation cost will vary, depending whether the training utilizes micro, mini, super-mini, or mainframe CADD systems.

The trainee costs include all benefits and wages stated in hourly terms. The Instructor costs are based on knowledge and experience, including advanced training. Not included is the cost of training the instructor. Development and reproduction costs of training materials have been broken down into cost per unit per trainee. This may vary greatly, depending on whether in-house developed material or third party developed materials are used. Expect in-house material cost to be higher.

(**EQ 1**) Calculate the total cost per trainee :

$$H_t * (C_t * N_t) = TW_t$$

(**EQ 2**) Calculate the total cost for workstation use :

$$(W_t * H_t) * (C_w * H_t) = TC_w$$

(**EQ 3**) Calculate the total cost for instructor :

$$H_t * ((N_s * I_a) * C_i) = TC_i$$

(**EQ 4**) Calculate the cost of training materials :

$$N_t * C_h = TC_h$$

**FIGURE 1**

*Equations for*
*Calculating Training Costs of CAD Personnel*

Using the inputs provided in **Table 1**, the cost for training one CAD technician can therefore be calculated as follows :

**(EQ 1)** 232 * ($18.00 *1) = $4,176.00
**(EQ 2)** (.5 * 232) * ($30.00 * 1) = $3,240.00
**(EQ 3)** 232 * ((1 * .5) * $25.00) = $2,900.00
**(EQ 4)** 1 * $200.00 = $ 200.00

Total cost for providing both initial and follow up training of one CAD technician for a period of approximately one-and-a-half years would be $10,756.00. The cost presented here may vary from firm to firm depending on workstation cost per hour, trainee and trainer salaries, and number of hours allocated for training. A major factor effecting individual training costs is whether the organization utilizes micro, mini, super-mini, or main frame based CAD systems. A search of literature on the cost of CAD training reveals that $10,000 represents a reasonable figure (Lazear, 1982).

## Determining CADD Training Tasks

In developing an internal training program, it is beneficial to develop an understanding of the various levels of personnel that will come in contact with the CADD system and the types of tasks they are required in conducting their jobs. Not all users of the system will require intensive training on the operations of the system. Some users may require only general introduction of system function and capability.

By understanding the skills requirements of the various personnel that will utilize the system, the program planner can determine what levels of courses should be offered. The first step is to develop a list of tasks that may provide a common core of knowledge required to operate the system. From this list, it is possible to identify what knowlege / skills an individual would require to function in a particular position.

This may be done through examining the various functions that an individual is required to know to perform their job. An occupational analysis should be conducted to determine the skills and knowledge required to perform at various job levels. This will assist the program planner in establishing objectives and designing the curriculum. The analysis will determine the tools and conditions to conduct the job; the aptitudes, skills and knowledge required by the employee; and the quantity and quality of performance required.

From identifying the tasks, the program planner may begin to develop specific lesson plans that provide basic instruction on each topic. The process may be broken into 5 steps consisting of (1) identifying the tasks or "technical jargon" that specifies an operation within the job , (2) setting behavioral objectives, (3) breaking tasks down into manageable operations or steps, (4) developing a set of lesson plans that provide instruction on that topic, and (5) provide some means of measuring the outcome of the lesson.

Each job consists of the combination of many operations or tasks that an individual must perform. Fryklund identifies eight points that may be used in identifying operations. These are :

> 1. It occurs frequently in an occupation with considerable uniformity of content ; it is relatively constant in time and geographically.
> 2. It involves teachable content.
> 3. It is a distinct unit which, when completed, makes the worker feel that he has came to a good stopping place.
> 4. It has its greatest value when combined with other operations; alone it is usually of little value.
> 5. The length is such as to make suitable content for a class demonstration.
> 6. When it is put with other operations in combination, they produce or service something larger without gaps or overlapping between them.
> 7. It involves depicting, shaping, forming, or assembling.
> 8. It can be broken down into definite steps of procedure. (Fryklund, 1970 )

## Multi-Channel Learning

Individuals tend to acquire knowledge through various sources and at various rates. The CADD training program curriculum should incorporate what is referred to in literature as a "multi-channel" approach . Individuals acquire new knowledge through three primary sources of stimulation. These include the following :

# Professional CADD Staff Development

1. **Visual**
2. **Tactile**
3. **Verbal**

A well organized training program will try to provide new information through several channels of stimulation. Developers of industrial CADD training programs must design their programs from the perspective that they are teaching adults. Material may be introduced through a combination of the following methods :

| METHOD | SOURCE |
|---|---|
| **Written** | Text books, Course Outlines, Handouts |
| **Oral** | Lecture, Audio / Video tapes |
| **Visual** | Audio / Video tapes, Transparencies, Demonstration |
| **Application** | Hands-on |

Reinforcement of skills helps individuals retain what they have learned. Skills should be introduced as a set of individual tasks that build upon each other. As one set of tasks are developed, another set may be introduced. A task may be introduced in the form of a lecture that uses both written material and visual aids, and reinforced at a session that provides individual hands-on application at a workstation.

Poorly prepared training materials combined with ineffective approaches to introducing the learner to new skills can lead to disasters. The student will become confused and frustrated, resulting in them giving up in defeat and failing to develop the necessary skills or acquire the knowledge to function properly. The result will make itself known as system productivity does not achieve anticipated levels.

## The Training Staff

Many large AEC organizations have permanent staff and facilities dedicated to providing user support and education. This may be in the form of a Management Information Systems (MIS) group that provides a broad spectrum of administrative and general computing support. If an organization has a number of CADD workstations and users, then it is likely that one or more individuals are involved in providing training to CAD users within the firm. What qualifications and abilities should a firm look for in personnel involved with setting up, managing and providing instruction for a CADD training program?

Selecting an individual to be responsible for conducting in-house training should be done with care. The trainer should possess the necessary skills and patience to work with individuals in an instructional mode. Many individuals may have the necessary knowledge on the subject, but may lack the necessary interpersonal skills that makes them a teacher. There are several important points to consider when selecting a trainer.

First, the individual should be knowledgeable in applying CAD to solving problems found within the firm. Usually one of the more experienced CAD technicians will find themselves called upon to assist others in using the various commands or functions on the system. They should have an expressed interest in assisting others to use CAD technology. It should be stressed that not all knowledgeable personnel make good instructors.

The second consideration is that the individual must have both the willingness and ability to teach. If the individual lacks the internal desire to assist others in learning, then they may not be a good instructor. The instructor should feel comfortable in both the knowledge (i.e., CADD applications) and can work with others on an individual or classroom setting. The final point is that the trainer should have good interpersonal skills and a knowledge of what processes are involved in introducing new skills to individuals. An ideal candidate would be an individual with some formal training in education techniques and the appropriate CAD skills and knowledge gained from experience.

Adequate supporting staff may be necessary in large organizations. Such a staff may include technical writers and commercial artists for the development of custom training materials and user documentation. This is particularly important where a CAD training program must support a wide range of courses for users at various levels.

Many small to medium sized AEC organizations may find it difficult to justify the cost of an internal instructor. Large organizations that utilizes the CAD/CAM system in a production environment may find it difficult to provide time on the system to train new users. Small to medium sized organizations may depend more upon the system vendor or consultants to provide training for their users. These firms should be careful in developing their training requirements. There are several alternative approachs to providing user training, come can even reduce the overall training costs for the organization.

## Alternative Sources of Training

Smaller AEC organizations may not opt for internal training due to cost restraints. It may be necessary to look to other resources outside the firm for user training. CAD training is available from various sources, both public and private, and at various levels of competency. There are eight major resources of CAD/CAM training available listed in **Figure 2**. Each source has its merits and is worth considering in planning corporate education.

1. **The Vendor**
2. **Internal Training Programs**
3. **Authorized Training Centers**
4. **Distributors of Hardware/Software**
5. **Special Seminars**
6. **Consultants**
7. **Technical Colleges or Institutes**
8. **Universities**

**FIGURE 2**
*Training Resources*

Of these eight, three primary alternative sources of CAD/CAM training should be investigated. These are :

**1. Contracting training services out to a third party (i.e., consultant, authorized training center, training service, etc.).**

**2. Indentifying a two-year technical institute or college that offers training on a system similar to what you plan to install.**

**3. Establishing a micro-based training facility using a Personal Computer (PC) version of the CADD software you will be using in-house.**

Care must be exercised in the selection of where training is to occur, and by whom. Many distributors lack the technical expertise to meet the needs of design organizations. They can sell you the product, and provide initial training but lack the depth of knowledge to provide specific training that may involve unique requirements of the AEC firm. In addition, many lack the technical support staff to answer application specific questions. Many vendors of PC CADD software, as a means of controlling training quality, have established Authorized Training Centers (ATC) to support their products.

Many colleges and universities have excellent continuing education programs and sponsor special workshops and seminars on specific topics relating to CAD, CAM, CAE, or CIM. Firms requiring training may contract for special sessions for their employees. Training may be done at your firms site, using your system, or at the facility of the educational institution. The content of custom training programs can often be tailored to meet your needs.

## Who Do You Train ?

When setting up an in-house CAD/CAM training program one must identify who is to be trained. The size of the CAD/CAM system, whether the system is centralized or decentralized and number of users within the organization represents integral components in determining who is to be trained. If the facility is set up in a centralized manner, then the number of users may be fixed through the use of dedicated personnel. If a decentralized facility is used, then there may be casual users located at numerous remote sites that require support. CAD/CAM education should provide training at three levels of personnel within a design organization (**Figure 3**).

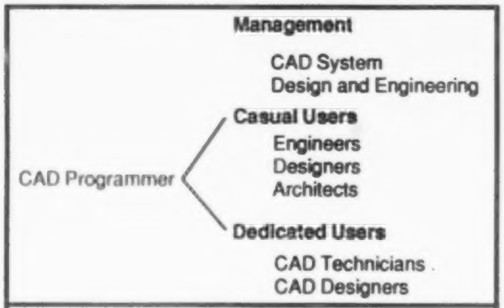

FIGURE 3
*Levels of Training*

After a system has been installed, training of design and engineering management within the organization should occur. There will be many questions concerning the type of work best suited for the system, how the work should be scheduled, the development of custom symbol libraries, and the effect of CAD/CAM on existing standards. CAD/CAM may require changes in the work is conducted within a design organization. To succeed, management must gain an understanding of this new technology. Be aware, there may be those who will find fault. These are the ones that must be won over to CAD/CAM through education.

## Career growth verses the traditionalists

The success of a CAD/CAM system depends upon the personnel selected to operate it. Determining which individuals are best suited for operator / technicians positions represents an important element in the successful implementation of a new system. When it is announced that a CAD/CAM system is to be brought into a design organization there may be mixed reactions. Some individuals may feel that CAD/CAM represents a means of providing new career opportunities. To others, CAD/CAM may represent an imposing force that intimidates. A common argument among many traditional diehards is that *"I've been doing it this way all these years so everyone else should do likewise if they want to gain experience"*.

## Selection of Personnel

Selection of personnel to operate and support a new system therefore involves an examination of individuals desires to accept and apply new technologies as problem solving tools. Operating personnel should be selected from within the design or engineering organization in which the CAD/CAM system is to be placed. Individuals selected internally best understand corporate drafting, design and engineering requirements and practices.

| | CAD/CAM Personnel | | |
|---|---|---|---|
| | Operator | Applications Specilaist | Systems Programmer |
| Knowledge of mathematics | ■ | ■ | ■ |
| Knowledge of computer organization | ■ | ■ | ■ |
| Knowledge of drafting | ■ | ■ 1 | ■ |
| Ability to visualize in 3D | ■ | ■ | |
| Experience in design | ■ | ■ | |
| Engineering background | ■ | ■ | |
| Previous CAD experience | ■ | ■ | |
| Good keyboard skills | ■ | ■ | ■ |
| Good communications skills | ■ | ■ | ■ |
| Management/supervisory skills | ■ 2 | ■ 2 | ■ |
| Computer graphics theory | | | ■ |
| Computer graphics hardware | | | ■ |
| General programming experience | | ■ | ■ |
| Experience in FORTRAN | | | ■ |
| Experience in Assembler | | | ■ |
| Specialized in one discipline | ■ | ■ | |
| Multi-discipline experience | ■ | ■ | ■ |

Notes :

1. If the Specialist or Programmer is responsible for modifying or developing new application packages on the system that involves drafting functions, then they should be familiar with topic.
2. Management and supervisory skills needed if individual is to oversee personnel (i.e., supervislor, lead programmer).
3. Systems programmer on the CAD/CAM system should be familiar with both mathematical concepts of CADD and hardware functions to write new graphics oriented programs.

Since CAD/CAM represents a new tool, experienced personnel will welcome the opportunity to work with it. In selecting dedicated users, look for individuals that are open minded and are enthusiastic about

# Professional CADD Staff Development

applying CAD/CAM to their work. In many cases, the challenge encourages individuals to seek new approaches to solving problems and improving productivity.

Both dedicated and casual users share fundamental skill and qualifications. A dedicated user changes the focus of their job from traditional techniques, to one that utilizes the technology on a daily basis. A casual user on the other hand, divides their time between traditional techniques and the use of CAD, then only when required to solve a problem. The dedicated users' system skills then can be expected to be higher than that of a causal user due to the amount of time spent on learning the system.

## Flexibility of Training

Industrial CAD/CAM training programs must be capable of developing the skills of personnel based on the manner at which the system is to be utilized within the design organization. It must be flexible enough to support a variety of users, and at various levels of job description within the firm. One approach which is best suited for support over a wide spectrum of users is the customization of training through a series of specialized modules.

This method consists of individual modules that provide specific instructional requirements that are beneficial in providing staff development training. Depending on the specific level of training requirements for individuals within the organization, individual modules may be "mixed and matched" to suite the requirements of various groups of users. By developing a modular approach to CAD/CAM training, it is possible to provide considerable flexibility within the program. **Figure 4** lists a series of training modules ranging from one day to two-weeks in length.

| Module | Length |
|---|---|
| **1. Basic System Operation** | **1 Week** |
| **2. Advanced System Operation** | **1 Week** |
| **3. User Programmable Language** | **3 Days** |
| **4. Applications Training - Introductory** | **1 Week** |
| **5. Applications Training - Advanced** | **3 - 5 Days** |
| **6. Menu Development** | **1 Day** |
| **7. Text Editor** | **1 Day** |
| **8. System Review** | **1 Day** |
| **9. Applications Review** | **1 Day** |
| **10. Operating System - Introduction** | **2 - 4 Days** |
| **11. Operating System - Advanced** | **2 - 4 Days** |
| **12. System Utilities / Diagnostics** | **2 Days** |
| **13. Advanced System Programming** | **1 Week** |
| **14. System Networking** | **2 Days** |
| **15. System Management** | **3 - 5 Days** |
| **16. Management Orientation** | **1 Day** |

Figure 4
CAD Training Modules

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## Biography

Steven R. Foster has over 15 years experience in the CAD/CAE industry. He has worked in the federal power utility industry as a CAD technician, supervisor, and applications specialist. Mr. Foster has worked on numerous micro, super-mini and mainframe based CAD/CAE systems.

He is a charter member of the National Computer Graphics Association (NCGA), where he has served as Tennessee State Director, Chapter Officer, and cochairman of the membership committee. Mr. Foster has a Master's degree in Industrial and Adult Education from the University of Tennessee at Knoxville. He is has published articles and software reviews in **PC Magazine**, **CADENCE**, and **Architectural & Engineering Systems**.

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# "THE WISEMAN (SIC) BUILT HIS HOUSE UPON THE ROCK"

## MANAGEMENT CONCEPTS

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## ABSTRACT

Management concepts help provide the foundation upon which all successful business endeavors are built. While the development of computer-based instructional materials is not always a business endeavor, these management concepts are still important to success. The management concepts described in this paper include: project management, business cases, market analysis, and personnel management.

There are several management concepts that help provide an important foundation for planning and performing the day-to-day operations of a computer-based instruction development program. These are:

- Project Management--to manage your efforts in a formal, organized way
- Business Cases--to help you analyze the resources required to produce the computer-based materials and compare them against the benefits to be gained
- Market Analysis--to help you determine your potential audience and, in conjunction with a business case, help you to better estimate the potential gains that may be achieved with your materials
- Personnel Management--to relate to the human resources that will be working on the project

## PROJECT MANAGEMENT

Project Management is the name given to the process of planning, organizing, staffing, motivating, and controlling the activities and people involved in producing a specific product. (Note that the term "product" is used in this paper in a generic sense to represent any planned effort involving the development of materials to be used on or with a computer.) Normally, it involves the management of a staff of people who have different skills (sometimes called matrix management) rather than a group of people with the same skills who are producing only a part of a product. However, depending upon the size of your development effort, your "staff" may just consist of yourself. In either case, the product will be some form of computer-based instructional materials.

Regardless of the size of your project, project management also involves using a systematic, formalized approach to the creation of the product. Successful project management usually involves:

- A well-defined statement of the product and its intended audience
- A description of the resources required to perform the tasks
- A project schedule
- A formalized development process with checkpoints
- A testing and evaluation process
- A staff (or a person) who is involved with the process and feels a sense of dedication to the project

## BUSINESS CASES

A business case is a general statement that compares the benefits gained from the production of an item against the costs to produce that item. Thus, it is really just a formal approach to a mental exercise that most people do whenever they are trying to decide to expend some effort. An important benefit of using a formal approach is that you will be less likely to neglect an important factor, and are more likely to make better, informed decisions about your project.

The significant elements of a business case include:

- A brief definition of the materials to be developed
- A brief statement about the presumed user of the materials
- A market analysis that describes how many potential users of your materials exist, how many are likely to purchase (or use) your materials, and an approximation of the amount they would be willing to pay for your them
- A list of the resources required with associated costs
- An estimate of the time involved to produce the materials (both aggregate and elapsed time)
- A list of assumptions made in preparing the business case
- An analysis of the costs versus the benefits

## A DEFINITION AND USE STATEMENT

This element of your business case is a general statement about what your computer-based materials are going to be and who is going to use them. It needs to be detailed only to the level required for estimating the number of potential users and the resources required to produce the materials.

For example, your definition and use statement could be: "A drill on factoring quadratic equations to be used by students taking Algebra II in my high school." Or, "A tutorial on aerodynamics to be used by student aeronautical engineers in many colleges." It would also be useful if you would estimate the amount of time an average student would use the materials. This figure could then give you a "rule of thumb" on which to base your estimates of the resources required to produce the materials.

## MARKET ANALYSIS

A market analysis involves determining the number of potential users of your computer-based materials and the percent of those who will actually make use of them. Even if you are just producing material for your own classroom, it is important that you make some statement about the number of people who will be affected through the use of your materials. Obviously, you are more likely to put greater effort into something that will be used by many people (such as a class or grade level) than something that will be used by just one or two people.

The first step to performing a market analysis is to determine the number of potential users (how many people there are within the target population). If your materials are to have limited use, this is a fairly easy activity. Using the example above concerning the factoring drill, you could analyze your potential users to be every student who will be taking Algebra II in your school during the lifetime of your "product." A reasonable estimate might be 50 students a year for 5 years, or a potential market of 250 students.

Then, you need to determine what percent of the potential users will most likely use the drill. In this case, you probably have a good idea of the variables involved in making this determination (such as: equipment availability, faculty attitude toward use, and student interest). So, assuming that all of the conditions are favorable, you might estimate that only 90 percent of the students will make use of your materials. Thus, your market analysis says that you expect 225 students to use your materials during the next five years.

If you are planning on trying to have your materials published, or distributed for others to use, an analysis of how much people would be willing to pay for your materials will help you decide how much effort you are going to expend to produce them. Obviously this task is harder than the one above and you must do a little research to obtain the best estimate. A publisher might be able to help you with this information, or you could obtain price lists for comparable products already on the market and use them as a base. This estimate is an important variable in your business case because it can dictate how much work you are willing to do and it can provide a determinant for subsequent trade-offs required during the development phases of your materials.

As an integral part of your market analysis, you need to determine if there are any products already available (or under development) that will satisfy your needs or perhaps compete with your product if you intend to sell it. Do not limit this analysis to just computer-based materials because other forms of instruction (such as workshops, lecture, video, and texts) can also compete for the same students or student time. Once you have analyzed your competition, you need to satisfy yourself that you can produce something better (or cheaper).

## RESOURCES

An important part of the business case is a list of the resources required to produce the materials and their associated costs. These costs will be compared with the estimated benefits to assess whether you should do the project or not. Resource elements to consider are:

- Staff and other personnel--be sure to include everyone from the people who are involved in the project on a full-time basis to consultants and/or clerical personnel who may be used as needed.
- Equipment, software, and other supplies--include the equipment required for developing the computer-based materials and, if different, the equipment that the computer-based materials will be presented on (especially for testing purposes); the software required for operating the equipment and writing the materials; and such supplies as diskettes, computer paper, and copiers.
- Facilities--include any overhead monies that would be allocated to your project, such as: space usage, furniture usage, secretarial services, etc.
- Miscellaneous expenses--include such items as travel costs, membership fees, reference texts,publication and distribution costs, and text and artwork preparation costs.

Try to be as specific with these costs as possible and always err toward more expenses than less. If you can justify doing the project with an inflated number, you will be in better shape than if you justify the project based on too low a budget.

## TIME REQUIREMENTS

You need to estimate the amount of time required to develop the proposed computer-based materials as well as the elapsed time. One way to estimate the amount of time required is to use a multiplier times the amount of student hours. For example, if you have estimated your course/module to require an average of 4 student hours and you think that you will average 200 hours of development time for every student hour, you would require 800 development hours. Another way of estimating the time is to analyze each phase in the development process to determine how much time you think that particular phase will take.

An estimate of elapsed time will help you obtain an idea of when the materials will be available. You can estimate elapsed time by reviewing the activities in each phase and scheduling your available time until the project is completed. Or, you may establish a date (like the beginning of a quarter) when you want the materials available for use, and then see how many hours you have to work each week to accomplish that goal. If you can't make your projected schedule fit your availability date, you may want to revise your estimate of the number of people who will be using the materials, or the scope of the materials, or the number of people involved, etc.

## ASSUMPTIONS

An important element of every business case is to list any assumptions you made during the process of analyzing the resources, costs, benefits, and time requirements. For example, you might have the following of assumptions:

- Only those students who require remedial work will use these course materials
- Students will have a computer lab to use whenever they want
- Instructors will be familiar with the instructional concepts and the operation of the computer
- All personnel will be available when needed
- All development team members will have adequate prior training in the process/programming/activities required for project development
- All required equipment and software will be available when needed
- The possible revenue from the sales of this product will be $7,875 (225 sales at $35 each)

Obviously some of these assumptions are already listed as part of your business case, but by gathering them together in one place, you can continue to review your assumptions to be sure that they are still true. If any changes are made to the assumptions, you will need to reexamine the decisions that you made based on those assumptions.

## COSTS VERSUS BENEFITS STATEMENT

The "bottom-line" of a business case is whether the expected benefits from using the materials outweigh the costs of involved in producing them. Usually, this statement is a monetary one, but in computer-based education there is also an intrinsic benefit that is often difficult to measure.

The following are examples of costs versus benefits statements for four different types of projects.

Example 1: A Drill For Personal Use--This example is for a short half-hour drill to be used within an instructor's classroom.

Development Costs:

| | |
|---|---|
| Personnel: 100 hours X $20/hour | $2000 |
| Equipment: One PC with monitor and printer | 1500 |
| Software: | 350 |
| Supplies: | 50 |
| TOTAL | $3900 |

Benefits:

| | |
|---|---|
| Intrinsic only: | $0 |

Conclusion: Now, this appears as though you shouldn't do the project because you will invest nearly $4000 for only intrinsic gain. However, most instructors do not put a pricetag on their development time and the PC and software may be available from the school. Consequently, the only out-of-pocket costs would probably be the supplies for $50, which most instructors would be willing to invest to improve student performance.

Example 2: A Tutorial On Geometry For Use In All District High Schools- This analysis is for a year-long project to teach basic geometry with an average student usage of 40 hours.

Development Costs:

| | |
|---|---|
| Personnel: 800 hours X $20/hour | $16,000 |
| Equipment: Three PCs with monitors and printers | 4,500 |
| Software: | 550 |
| Supplies: | 350 |
| Miscellaneous and Overhead | 1,000 |
| TOTAL | $22,400 |

Benefits:

| | |
|---|---|
| Intrinsic only:<br>(perhaps less instructor time) | $0 |

Assumptions: Student usage of computers will be readily available.

Conclusion: This project looks as though it would be difficult to justify. However, an enterprising instructor might be able to suggest this project be undertaken by a student club (such as a computer club or the math club) or by a class of gifted students, thereby eliminating the onerous labor costs.

Example 3: A Tutorial On The Use Of A New Accounting System For A Fast-Food Chain--This analysis is for a tutorial to be mailed out to 1,500 fast food restaurants to teach them how to use a new accounting system. The tutorial is expected to take approximately one hour.

Development Costs:

| | |
|---|---|
| Personnel: 300 hours X $30/hour | $9,000 |
| Equipment: Two PCs with monitors and printers | 5,000 |
| Software: | 750 |
| Supplies: | 300 |
| Art and Text Production | 2,000 |
| Distribution costs (1500 diskettes, reproduction of text, postage) | 7,500 |
| Miscellaneous and Overhead | 3,000 |
| TOTAL | $27,550 |

Costs per restaurant: $18.33

Benefits: Non-expenditure of travel costs: $45,000; no significant loss of time from the job; ability to train more than one person per location.

Assumptions: Every restaurant has a personal computer that they are currently using for accounting. Travel costs based on prior history (about $300 per attendee).

Conclusion: Obviously, this program looks as though it has significant pay-back for the corporation, and, therefore has a very favorable business case.

Example 4: A Course On Introductory Biology For Use In High Schools and Colleges (Commercially-Produced)--This analysis is for a complete course of 80 student hours on introductory biology to be distributed commercially. The course would have many graphic images, tutorials, drills, tests, and some discovery learning.

Market Analysis: 250,000 potential users with a market penetration of 25%, or 62,500 students.

Development Costs:

| | |
|---|---|
| Personnel: 16,000 hours X $35/hour | $ 620,000 |
| Equipment: Six advanced PCs with color monitors and printers | 30,000 |
| Special graphic devices | 6,000 |
| Software: | 2,000 |
| Supplies: | 2,000 |
| Art and Text Production | 25,000 |
| Distribution costs (37,500 diskettes, reproduction of text, and postage) | 225,000 |
| Miscellaneous and Overhead | 50,000 |
| TOTAL | $ 960,000 |

Costs per student: approximately $15.00

Benefits:

- Revenues ($18.50 per course sold X 62,500 courses = $1,156,250
- Profit ($1,156,250 - 960,000) = $196,250

Assumptions:

Students have personal computers available for use.

A team of 6 to 10 people will work a year to 18 months on the project depending on the people available and the schedule requirements.

Conclusion: This project has a profit margin of a little over 20%, which is usually considered quite good. However, you would have to sell 51,892 copies before you would begin to make a profit.

## PERSONNEL MANAGEMENT

Personnel Management involves selecting the development team members you are going to have work on your project, assessing their qualifications, and assigning the work they are going to perform. It also involves analyzing their performance and keeping them motivated.

## PERSONNEL SELECTION

Your first task will be to decide how many people you will need. The business case developed earlier will help you decide this. For example, in Example 1, you would probably not involve too many other people than yourself and maybe a few test subjects, so there is no real need for personnel. In the second example, if you should decide to do it, your "staff" would be somewhat dictated to you by the students who were available.

In the third example, your "staff" would probably consist of yourself, an instructional designer, an accountant, a programmer, a documentation person, and, perhaps, a graphics designer. In this case, the staff would either work on this project part-time or full-time for a short period of time.

The fourth example is more complex, requiring 16,000 hours of development time. Obviously, you would need a full-time staff to help you develop this product. With projects of this size, it is suggested that you include at least one person who has responsibility for each of the major roles and their activities. Then, you need to match the available people against the resources required. For example, because in this case you are developing a biology course, you may require as many graphic artists as you do programmers. Thus, your team makeup would reflect the project to be developed.

## JOB DESCRIPTION

Once you have decided what tasks people are going to perform, you need to develop a performance statement/plan for them so they know what their roles are. The job description should be as specific as possible, especially in those areas where responsibilities may overlap. Precise and clear job descriptions help prevent role ambiguity, reduce conflict, and help ensure more efficient operations.

## SUMMARY

Management concepts used in a typical business environment can provide a good foundation for the development of computer-based instruction. These concepts help you make the trade-off decisions that are inevitable during the development of any product. And like the parable, if you have built your house upon the rock, your efforts will not crumble over time.

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# "FOR WANT OF A NAIL...": MANAGEMENT TOOLS AND TECHNIQUES

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## ABSTRACT

Good management tools and techniques can make the difference between a successful completion of the development of a computer-based program and one that fails. Some of the techniques described are: the team approach, scheduling methodology, project notebook, specifications, prototypes, and a project room.

There are several techniques that you can use to help you manage, organize, and control your project. Management techniques that have found to be useful include:

- Using the Team Approach. By forming a team of people to serve one or more of the roles in the creation of the courseware materials, you will be able to draw on the various expertises rather than try to accomplish them all yourself.
- Using a Scheduling Methodology. By establishing a schedule that has been agreed to by all the members of the project team, you can use it to help control the progress by making sure that you stay on schedule or revise it if necessary. You may also want to establish a series of checklists as part of your schedules to ensure that each point in the checklist is completed at the appropriate time.
- Using a Project Notebook. A project notebook allows you to keep a record of all of the important decision points of your project.
- Establishing Specifications. Specifications are definitions of those items, such as screen layouts, terminology, operational considerations, and style that you want to establish at the beginning of the project so that everyone is consistent from the start.
- Using a Prototype. A prototype is a small working sample of a portion of your product that can be used to test your initial design and specifications before you develop the rest of the product.
- Using a Project Room. A project room is a place where you can display the project's status, the physical design of the the product, and any other material that is pertinent to team or external communication.

## USING A TEAM APPROACH

The organization that you choose to plan, define, design, develop, implement, distribute, and support your computer-based instructional materials, obviously depends on the scope of your effort. If you are creating materials for personal use, and you are experienced with computers and computer-based training, you may want to perform all the tasks yourself. If you are going to create a product for distribution to others and/or one that involves more than a few hours of student interaction, you are more likely to create an effective course/module of instruction by having other people work with you in a team.

# "FOR WANT OF A NAIL": MANAGEMENT TOOLS AND TECHNIQUES

In this paper the assumption is that you are working with a team of from 5 to 10 people who serve the various roles required for developing a commercial product. Some of these people, such as the instructional designer, may play a major role in the effort, while others, such as, the graphics designer, may play a minor role. Generally, these roles are:

- Someone to manage the project--if you want to take a more active role in designing and developing the project, you may want to have another person perform the management role.
- A content expert--someone who understands the subject matter to be conveyed and how this material can be divided into workable units of knowledge. The responsibilities of this role is not significantly different from the role of a text-book content expert.
- An instructional designer--a person who understands the educational and psychological aspects of learning and how best to defineinstructional objectives and present materials to obtain those objectives.
- Developers--these are the people who write the programs and documentation that create the final product. These roles begin with the beginning of the project and continue after the product has been distributed for use by the target population. This role in a large development project usually involves more than two people.
- A graphics designer--a person who has been trained in aesthetics and who knows how to present materials in a motivating and effective manner.
- A reviewer/evaluator--a person whose primary responsibility is to ensure at each point in the process that the product is meeting its objectives.
- An editor--a person who is responsible for the text that appears on the computer and the accompanying documentation. This person may be the same person who performs the documentation role; however, most writers benefit from having their work edited.
- A usability expert--a person who has been trained in the interaction of media to the human. In this case, you would want someone who can advise you on the design of the student interfaces and who will help you determine how to test your product to ensure that it is meeting the defined objectives.
- Support personnel--people who may serve additional functions, such as word processing, media installation and support, and other clerical personnel, as required. These roles are not commonly part of the team with continuing responsibilities in the creation of the product, but are ancillary. Often these people can be hired on a temporary basis or "borrowed" from other departments or sources as necessary.

## USING A SCHEDULING METHODOLOGY

Because estimates of the time required to develop one hour of effective course materials runs from 100 to 500 hours, it is very important that you establish a schedule of activities and monitor your progress according to that schedule. A checkpoint schedule defines when each phase is to begin and end and can thus be used to keep from wasting valuable time and/or to make appropriate schedule adjustments. (See Figure 1 for an example of the schedule.)

---

DEVELOPMENT CHECKPOINT SCHEDULE

| Phase | J | F | M | A | M | J... |
|---|---|---|---|---|---|---|
| I Business Planning | | | | | | |
| II Definition | | | | | | |
| IIR Review | | | | | | |
| III Design | | | | | | |
| IIIR Review | | | | | | |
| IV Development: | | | | | | |
| Programming | | | | | | |
| Documentation | | | | | | |
| V Test/Evaluation | | | | | | |
| VI Distribution | | | | | | |
| VII Support | | | | | | |

Assumptions:

Figure 1. Example of a Development Schedule

Today, there are several software packages available that help you create and update a schedule. Such packages that you may want to use are: Lotus 1-2-3, the Harvard Project Manager, Project Scheduler 5000, and SuperProject.

## HOW TO ESTIMATE THE DEVELOPMENT TIME REQUIRED

The time required to plan, define, develop, and implement computer-based materials obviously depends on:

- How complex the subject matter is
- How thoroughly you intend to cover the subject matter
- How complex the selected instructional strategies are
- How many different forms of media you intend to use
- Whether you need to design your materials for use in various environments and for different delivery systems
- How experienced the members of the team are both in the process of creating computer-based instructional materials and within their own functions
- How large and quality-conscience the market for your product is
- Which programming language(s), authoring language(s), or authoring system you plan on using to create the materials
- Whether the resources are available when you need them (including the implementation subjects)
- Whether there are any pre-existing materials, models, prototypes, and guidelines or specifications that you can use in the development process

### Time Estimates

The following "rules of thumb" can be used to help you develop the checkpoint schedule. As you develop the schedule, you may want to include the major team members in the discussion to make sure that they agree with your time estimates.

- For the Business Planning Phase--approximately 5 percent of your time will be spent on these activities. For example, if your total estimated time is 18 months, you would want to allocate nearly one month in this phase. If you are used to managing, defining tasks, and establishing schedules, this phase may take you less time.
- For the Definition and Definition Review Phases--approximately 10 percent of your time will be spent on these activities. Thus, in the example stated previously, you would need to allocate approximately two months for these phases. If your team is very familiar with the subject matter and the instruction goal is not complex, you may spend less time in this phase.
- For the Design and Design Review Phases--approximately 20 percent of your time will be spent on these activities. To continue the example, you would need to allocate four months to these activities. This may seem like a lot of time spent before the "real work" begins, but if this phase is completed according to specific guidelines, a lot of typical rework time will be saved. If your team has developed course materials previously and models/prototypes and guidelines have already been established, then this time may be shortened.
- For the Development Phase--approximately 40 percent of the time will be spent on this phase. Thus, in this example, you would allocate approximately eight months for development. While there is testing and review that may take place within this phase, the formal testing of the output of this phase is reserved for the next phase. The programs and the documentation should be developed at the same time. However, depending upon your instructional objectives, the documentation portion usually takes about half the effort of programming. (Remember that the documentation person must also read all the text screens to ensure their accuracy, style, and conformance to the guidelines.)
- For the Testing/Evaluation Phase--approximately 20 percent of

your time will be spent on this phase. In this example, allocate three months. This should also give you enough time for the programmers and documentation people to make any changes that are required and prepare the materials for distribution. If you are unable to schedule test subjects from the target population during this calendar time, you may need to reflect that information in your schedule. (For example, if your materials are to be tested in a classroom and the class doesn't meet until the next quarter, you will need to delay it until then or find another test population.)

### Methodology

To obtain a rough estimate of the number of months it will take you to develop the materials, decide on a number to use as a multiplier. The multiplier should represent your best estimate of the approximate hours that it will take to develop material that the typical student would spend one hour with. (A good estimating safeguard is to do your best job of estimating the time and then automatically adding 50 percent to that value.)

So for example, assume that you estimate that it will take you approximately 250 hours for every one hour of student time. Thus, for an 80-hour course in beginning botany, you would spend 20,000 hours of development time (250 x 80), or 500 weeks or 125 months. Thus, unless you want to spend 10 years developing the course, you would want to use a team. Assume you used seven regular team members in creating this product, it would take you approximately 18 months to complete it (125/7 = 18).

Now that you have established 18 months as the development time span, you can begin at the date when you intend to begin the project and lay out the phases for the next 18 months. Where you wind up is the date when the computer-based instructional materials will be ready for distribution. However, you need to be sure that you leave appropriate time for holidays and vacations and/or school schedules to make sure there are no conflicts. If the result is that your materials won't be ready when you want them, you need to consider adding additional resources.

## USING A PROJECT NOTEBOOK

A Project Notebook is a communication technique that allows you to keep a record of all of the decisions that you make. As such, it is an easily-accesible, centralized compendium that any member of the team may refer to when some specific information is required.

## THE ADVANTAGES TO USING A PROJECT NOTEBOOK

A project notebook has several advantages; it can help you:

- Provide a management tool that helps keep the project organized
- Communicate schedules, specifications, guidelines, objectives, and review comments to current and new team members
- Commit the team members (in writing) to the schedule, activities, and objectives
- Gather historical data on your schedule, budget, and development performance so that if you choose to develop subsequent material, you will know where you can improve

## TYPICAL CONTENTS OF A PROJECT NOTEBOOK

The following is a list of items that you may want to consider keeping in your project notebook.

- Project Organization--who the various team members are and what responsibilities they perform. If you have any outside contacts, you may want to include their names and addresses.
- The Business Case--include a copy of the business case upon which you are justifying the development effort.
- Project Schedule--include the general schedule developed for the entire project and any individual schedules. Be sure to include all updates to the schedule and reasons for change.
- Project Budget and Resources--include a list of the resources required, any assumptions, and a proposed budget. You will want to

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review your budget performance periodically and include the performance statements in the notebook. If there are people who have provided their service on a gratis basis or equipment that has been provided free-of-charge, make sure that your budget statement reflects these resources, as they may cost the next time.

- Computer-based Instructional Materials Definition--include the definition form which lists the general objectives of the training, the target population, the general content and instructional strategies, and so on.

- Materials Design--include any instructional design forms, course maps, or storyboard sequences that show how the materials are to be presented to the student. As the project is developed, this section will grow from the definition statement to the actual design. Make sure you update the necessary information as the design changes.

- Materials Development--as the instructional programs and documents are developed, they should be included in this portion of the notebook. As changes are made, make sure that each new version is included and contains an indication of the reason for the change(s) and its revision level.

- Testing/Evaluation--in the beginning this section should include a test plan. As the process continues, add the review comments and suggested changes.

- References/Bibliography--include, as necessary, a list of any documents (articles and texts) that either your materials may be used with or that the project team might use to assist them in development.

- Chronological Log--include a record of team meetings, discussions, and decisions, and any other conversations that are held with people external to the project (such as: publishers, temporary employment agencies, copyright lawyers, and so on).

- Other--include any correspondence pertinent to the project, contracts, product descriptions, or any other documents that you feel would benefit the project as a whole.

## ESTABLISHING SPECIFICATIONS

Specifications are those rules/ guidelines that are used in the development and support of your project. They include such things as: coding techniques and labelling conventions, screen layout and design, conventions for the use of special keys on the keyboard, style guides, and wordprocessing standards. These specifications should be established at the beginning of the project and at each review, everyone involved should make sure that none of these specifications are violated. This activity will save you time in the Development and Test Phases because it will help to ensure that the work is consistent.

That isn't to say that specifications can't change. It is natural during a development process for some of the decisions that were made previously to not fit every situation. However, no one person should be allowed to change a specification without some kind of approval by the person who has responsibility for the specifications (usually the manager). It is then necessary to make sure that every team member has been informed of the change. In some situations, you may want to make sure that every team member has a printed copy of the specifications and gets printed pages of the changes when they occur.

Some specifications, such as those used in the programming process, are best established by the person(s) responsible for that role. Thus, during the Definition Phase, you may want to have those persons responsible for specifications develop the standards that they think are appropriate and then present them to the group for review. In some situations, team members with different roles (such as the graphics designer and the programmer) may want to work together because the specifications may require knowledge of both fields.

The specifications that a programmer, documentation person, graphics designer, and usability expert might want to consider are discussed in the chapters that relate to those roles.

## USING A PROTOTYPE

A prototype is a small, working model of a portion of the computer-based instructional materials that are to be created. By using the specifications that were developed earlier and the performance objectives for this particular portion, the programmers and documentation people would develop the model. In this way, everyone can review the design and agree that the approach and specifications are correct enough for proceeding and that the work is feasible. It also allows you the opportunity to review your time estimates to see if they are realistic.

Once the prototype is developed, if there are any problems that exist, the prototype can be updated until it represents a effective model on which the rest of the materials can be based. Thus, the remainder of the development work will be more efficient and potential errors will tend to be eliminated at a time when they don't get propagated through the next several months of valuable work.

## USING A PROJECT ROOM

On some projects, managers use a special room (sometimes a conference room) that is set aside to visually display the project's organization, schedule, status, and design. You might consider using such a room to contain some of the more pertinent information that is contained in the project notebook. Then, if you also use the room during all department meetings, review sessions, design sessions, and so on, the whole team can readily visualize the status of the project and any changes as they occur.

This type of room is also very useful for displaying the storyboard or other visual representation of the entire organization of the computer-based materials. Often, it encourages dialogues between the various team members, such as between the instructional designer and content expert or between the instructional designer and the programmer. When the entire course/module is displayed before you, it is easier to see where items may be missing or where branches may more logically occur.

## USING FORMS AND CHECKLISTS

The use of checklists and/or forms wherever you want to consistently document definitions, designs, and progress help ensure consistency, communications, efficiency, and completeness. These forms should be designed during Phase I and modified as appropriate throughout the development phases.

One form that is particularly useful is a form to record comments from those people who use and test your courseware. When creating this form be sure to include a place where you can keep track of the comment and how it was handled.

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# LESSONS LEARNED IN COMPUTER-BASED LEARNING

## A PERSONAL TALE OF THREE DECADES

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ABSTRACT-- I have been associated with computer-based learning (CBL) at a number of institutions over the last thirty years. At a large number of them, I have initiated CBL efforts. This paper discusses the various situations, the lessons learned, and recommendations for individuals and institutions as they seek to make CBL a reality. Particular attention is given to the PLATO system, in academic, industry training, and the commercial contexts.

## INTRODUCTION

Upon encountering computers in 1959, and the PLATO concept a few years later, I had a strong feeling that the combination of computers, learning, and creative people make for an extremely powerful tool to assist in solving the significant problems of the world. Today, three decades later, the feeling has intensified, despite the many frustrations which have accompanied being closely associated with this field of computer-based learning (CBL). The rewards have been many, and the promises even more exciting during the time when many of you were just discovering this arena. It is truly a stimulating adventure to have such an opportunity. So it is only fitting that this paper, which looks at the past with recommendations for the future, ties in with the conference theme of "creativity through analogy". Analogies presume some knowledge of what already is, and recognizing similarities with current or prospective conditions. The creativity comes from exploiting these similarities and building on successful ideas, while adding new ones. So it is with such an intent that a number of previous experiences with CBL are presented. The "lessons learned" from such experiences, the successes and failures and the underlying reasons and follow-on consequences, are offered to the reader. This is done with the hope that we can build on one another's shoulders, rather than on one another's feet!

This paper does not intend to be exhaustive in surveying the field of computer-based learning. Nor does it intend to give a summary of points of view from many people. It does present the salient points of the field from the perspective of an individual who has participated actively in the area for a substantial number of years, and from a number of viewpoints. These include user, academic researcher and author, industry manager of internal CBL efforts, industry manager of CBL products for the home, and now academic department head who wishes to bring high-quality, effective, and efficient CBL to his university.

The analogies which arose from such a multitude of perspectives have been of considerable assistance in formulating successful efforts. The analogies from the richness of the computer science profession are equally powerful. As such a practicing professional since 1963, in both academia and industry, I bring the knowledge and practice of software engineering and expert systems to CBL as well. The innovation possible by clever amalgamation of these strongly-related fields is only beginning to be understood. Perhaps one of you, the inspired reader, will spot an idea or two through which creativity by analogy will makes its power felt for generations to come.

## THE 1960'S: A TIME OF GESTATION

I entered the University of Illinois in the fall of 1959, fresh from an excellent suburban high school outside Chicago, and with a deep abiding interest in rockets and space. Engineering physics was the means by which I would attain my goal of landing on the moon one day, just as I had predicted that someone would do during my 1957 physics class. Within a year, this interest had led to discovering the Illiac I digital computer, housed in the basement of the Engineering Research Laboratory (ERL). Before the end of my college career, I was working as a research lab assistant on the Illiac I, the IBM 7090, and the IBM 650. Only faintly heard were rumors of some people in physics who were working on the top floor of the same ERL building. There were indications that a particularly inspired faculty member was trying to simulate physics experiments by use of computer, with the intention of using such simulations for his students to aid in their learning. Not until the end of this decade, around 1968-69, did I learn that the "inspired" faculty member was Professor Donald Bitzer. Don came to Colorado State University, where I had earlier helped start the computer science program, after receiving advanced degrees from Stanford and Carnegie Tech. There, he demonstrated the current ability of PLATO to deliver effective interactive instruction via a computer which was physically located at the University of Illinois, a thousand miles away! This piqued my interest considerably, having previously considered computers as excellent scientific and business tools. By the next term, I had put together an experimental course on "computer-assisted instruction" (CAI).

What had been learned about CBL during this period? The most important was simply the fact that a computer could be used for instruction -- an "obvious" analogy of applying computing power and interactivity to the process of learning. Also discovered was that CBL did exist -- it was not just a theory -- and that it seemed to work on a very small scale. Moreover, people were extremely excited about it. Their creativity was astounding!

## THE EARLY 1970'S: CBL SPREADS TO ACADEMIA

Within a few months of receiving my doctorate in computer science from Washington State University in 1972, I had accepted a position as assistant professor at Indiana University - Purdue University at Fort Wayne (IPFW). No sooner had the first semester started than my department head, Professor Maynard Mansfield, who knew of my interest in CAI, asked if I would be interested in attending a PLATO workshop for prospective faculty authors at the University of Illinois. I jumped at the chance, and upon returning, became the first site director for PLATO in Indiana. That the plasma panels for PLATO were made by the Fort Wayne firm of Magnavox also helped!

The relationship with Bill Golden at the Computer-based Education Reserch Lab (CERL) (same ERL building as twelve years earlier) began with his leading our workshop, and the manifold skills he displays to this day. His appreciation and work for CBL in general and PLATO in particular is an invaluable contribution to the success the field has today, in my opinion.

Courses were begun immediately on CAI and PLATO. The "addiction" of students to the system was just as strong at IPFW as system-wide. Suggestions were made about indexing the hundred or so lessons by subject and keyword, as is done today in the on-line catalog. Rather than have the students continue to develop "shift-stop-itis", I wrote a grant for faculty development of CAI materials. The grant teamed faculty from five disciplines with students trained in the Tutor language of PLATO. The work proceeded as recommended by Bill Golden and other experienced authors, using team design, peer review, and what we now call rapid prototyping: the involvement of the end-user in the courseware development cycle. The lessons which resulted were tied into other existing modules by all the faculty involved. Movies were made of the products and the process, and were shown to a large number of local schools. A number of local industries even extended invitations to be informed about how students were using this new mode of learning. The State of Indiana commissioned a group of academics to formulate a strategy for introducing CAI to higher education in the state, and requested my assistance.

At approximately the same time, I began the classroom use of the Personalized System of Instruction (PSI) first promoted by Fred Keller (Modesitt, 1974a, 1974b, 1975). This system consists of several major components with the emphasis being on mastery-based learning, along with self-paced instruction, lack of lecture, written material for each unit, and peer tutors. I found that the growing base of courseware on PLATO could be used to augment the written material. Soon, I discovered that the strictly individual mode of learning stressed by Keller was inadequate for the type of education I wished to promote. The addition of group projects was facilitated by the networking capability of PLATO and the various notes features. All of these capabilities were used in a different environment, when I taught a graduate course in CAI at the University of Nebraska in the summer of 1975.

The lessons learned during this period were extensive. CAI had grown from being an interesting "toy" or research prototype to becoming a feasibility one. CAI really could work on a reasonable scale in a university environment, other than the one in which it had been created. Faculty could be motivated and convinced that the development of high quality CAI software (courseware) was a possible route to tenure and promotion. Many students could grasp the essentials of programming in an instructional language, and quickly outdistance their faculty teachers in this regard. These same student programmers could also develop a sense of "ownership" and "monopoly" of a scarce resource -- PLATO terminals -- to the detriment of the end-users. Finally, it was realized that CAI could be valuable component of and addition to other modes of instruction.

## THE LATE 1970'S: INDUSTRY "DISCOVERS" CBL

Soon after giving my first talk at an ADCIS conference (Modesitt, 1976), a feeling of restlessness set in, and a decision was made to move to California on a visiting professorship, where the CAI course was again given successfully. The uneasiness finally manifested itself in a major decision, to return to industry after a 10 year absence. I felt that the full potential of CAI was not being fulfilled in the university. The advent of the personal computer in the same period helped me understand that CBL could be a vital application in the home environment as well.

While working as a software engineer and teaching courses for industry, it became apparent to me that courseware development could also profit from some of the methodology being used for large software projects. Moreover, the cost of training new employees and retraining older ones in new methods was substantial in industry. Here, students were paid while they learned new topics, a radical departure from the university! Hence, my definition of computer-based learning was expanded to include not only computer-based education (CBE), but also computer-based training (CBT).

Within a year, I had persuaded my manager to lease a terminal with PLATO access to the Control Data System (CDC had taken on PLATO as a product line in July, 1976, after NSF funding ceased for CERL). We also had access to the CERL system, since much of the research and development continued to be performed there (and still is!). I hired people to develop courseware for the version of Pascal being used by my employer, and selected one to be the co-site director. These people were hired as a result of numerous conversations over PLATO -- truly long-distance hiring.

To increase the leverage of CBL at the corporation, I agreed to be the first corporate education director and promoted computers and training across many of the divisions, both at the national and international levels. Corporate-wide forums were held on CBL as well as ones involving training directors involved with CBL from other major corporations and universities. It was during this time that Bob Fratini of Western Electric, Chuck Buchanan of United Airlines, and I started the =industry= notefile to provide a forum for the rapidly growing number of industries on PLATO.

The lessons learned in this five year time frame were critical ones: industry was a large and motivated location in which learning was gaining importance rapidly (Modesitt, 1981a, 1981b, 1982). High technology firms were seeing the knowledge of their expensive employees become obsolete quickly. Cost-effective solutions to training needs were very much in demand. And CBL (CBT) was a very promising such technology.

## THE EARLY 1980'S: CBL AND THE HOME

With computers and instruction finding widespread application in the context of schools and work, it was clearly only a matter of time until the same combination appeared in the home. A number of small computer games and some drill-and-practice math lessons were already on the Apple and Radio Shack home computers, most of which were initially found in the lower grade levels.

In 1981, as I was walking from a meeting on CBT with one division to another, a simple idea occurred to me -- why not migrate the existing high-quality and proven PLATO courseware now available on a large time-shared mainframe to a home computer? To be sure, there would be some loss of screen fidelity, but the gain in other areas would more than compensate: dramatically increased availability via low cost of successful and proven educational software. This would be software which had already amply demonstrated the ability of students to improve their learning. It would also be necessary for these same home computers to be tied into the larger network at times.

The next several years were spent in bringing this dream to reality. As program manager for educational software on the home computer of a major corporation, I worked with Control Data Corporation to move over 800 hours of proven PLATO courseware to a home computer environment. Concurrently, collaborative efforts were made with many experienced PLATO authors to develop new courseware for the home market. Contracts were let to specify, design, and implement a PLATO terminal emulator for the small computer. Suggestions were given on the requirements of new authoring systems and languages being developed by Control Data and CERL. Only a little time was available for writing papers detailing all the exciting work underway (Modesitt, 1983).

The products were brought to market in 1983, selling well into the home via retail outlets, as well as the schools. Much to the amazement of myself and the general computer industry, the corporation decided to leave the home computer market within a few months after the first releases. Although the substantial initial investment had already been repaid over 50% within those first few months, the decision was irrevocable.

Lessons learned in this era were very hard ones: commercial markets for CBL were not yet well-established, and the providers of such programs had best be conservative. Hard work and long hours do not guarantee success, even when combined with the brightest people in the business of PLATO software, whether university (CERL) or industry (CDC) or independent. It is marvelous to have creative ideas, yet that is not sufficient. Dreams die hard...

## THE LATE 1980'S: CBL AS THE YOUNG ADULT

The initial concern about the death of the dream for affordable computer-based learning was inaccurate. The "wrong" home computer had simply been selected for this first venture, in one respect. One has only to look around in industry, schools and the home to see that computers and instruction are far more pervasive than was ever imagined. PLATO systems abound across the world in a variety of forms. High-end computer workstations are announced solely for the higher education marketplace. The CERL PLATO system has delivered nearly 20,000,000 hours of instruction on 100+ systems. NSF and NIE grants for CBE are too numerous to mention. CBT is taken for granted in most high technology industry. Textbooks abound. Good quality courseware at reasonable cost is as close as Kinko's copy centers. ADCIS is experiencing continued strong growth after thirty years.

I have taken a break from day-to-day involvement in CBL, choosing instead to concentrate on updating "credentials" in software engineering and expert systems in both academia and the space industry (Modesitt, 1986, 1987b, 1987c, 1988a, 1988b, 1989a, 1989b). Significant work on the California State PLATO system at was squeezed out by too-long days in hectic southern California.

The time has, however, come to return to CBL. The field has matured to the point where it is no longer the "new kid on the block" fighting for respectibility. Enthusiasm is very much present, but this time it is tempered with a good dose of reality. Creative people continue to come into the field, and the good ones already present continue to devote their energies. Consequently, as a new department head of computer science, I am far better prepared to help my university participate in this evolution of computers in learning. Faculty who apply for and receive grants to develop new skills in CBL are more likely to meet with long-term success. The equipment is better and more affordable, with network access dramatically improved. The courseware base continues to grow in quantity and quality. Development methodologies and tools are more refined. Selection criteria for the "best" subject areas are in use. There are more qualified people. CBL has matured to become a commercial success.

## LOOKING TOWARD THE 1990'S: COMING OF AGE FOR CBL

I find it very difficult to submit this paper for a particular SIG in ADCIS. As is obvious from the preceding, my CBL experience encompasses far more than just PLATO. Moreover, the future is definitely broader than just PLATO. As a person with both academic and industrial experience in the computer field for 25+ years, I find it impossible to ignore how CBL is already being influenced daily by efforts in computer science, software engineering and expert systems. In addition to working with people such as university professors and human resource developers, more ADCIS members should begin to interact extensively with developers of large software systems. The methodologies have an enormous overlap! ADCIS can contribute immense amounts of practical experience about human interfaces, something sorely needed in the computer science area. There is now an artificial schism between CBL, as helping people learn how to do something, and expert systems, as helping people do something directly. I am certain that efforts are being expended in these respects, however, their visibility is zero, for all practical purposes. As a software and knowledge engineer who is also a professor, and hence has a very large repertoire of professional reading, I am amazed at how little CBL has pervaded my other fields of interest.

I challenge ADCIS to make its significant presence known outside the field of CBL. I am firmly convinced that the results will make former successes pale in comparison.

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# PLATO IN AN AFRICAN ADULT EDUCATION CENTRE

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## ABSTRACT

This paper describes the use of a PLATO computer-based education system in an African, multi-purpose adult learning centre. It focuses on the use of high-technology in a predominantly Third-World environment and briefly considers international transfer of courseware. The paper gives particular attention to student responses to the computer-based learning system.

## SOCIO-POLITICAL BACKGROUND

This case study of the use of PLATO computer-based education is set against the background of the socio-political realities of South Africa in the last decade. In terms of government policy, education in state schools is provided along segregated lines, with an inequitable allocation of funds and resources. Despite recent efforts to normalise this situation, the attrition rate for black pupils remains unacceptably high.

The drop-out from schools results in numerous people entering the job market with less than adequate schooling, hence adult education is vitally important, both for individuals as a second chance and for commerce and industry, to provide adequate trainable human resources.

## ST ANTHONY'S ADULT EDUCATION CENTRE

St Anthonys, the subject of this case study, is a multi-purpose education centre run by the Catholic Church. Its express purpose is convincing "all men of their personal worth as the beloved people of God..." (St Anthony's brochure, 1979). The centre is situated in the mining and industrial town of Boksburg, about 20 miles from downtown Johannesburg. It is a centre of learning and reconciliation, sited ironically enough, in a town which in the past 18 months has become synonomous with racial intolerance. The centre is used for teaching academic, vocational and technical subjects at all levels, to school leavers of all ages. About 1000 students use the facilities of St Anthonys at any one time, while total student enrolment is in excess of 4000.

## U.S. CORPORATE INTERESTS IN SOUTH AFRICA

From the mid-1970s, various groups in the US and elsewhere have expressed strong condemnation of the policy of apartheid by calling for disinvestment of US companies from South Africa. For some time, this pressure was countered by many who maintained that the présence of US companies in South Africa was to the benefit of underprivileged people. Critics were quick to respond that talk was cheap and corporations doing business in the country should return something to the people in a way which could be measured. So were born the various "codes of conduct", in terms of which, signatory companies would ensure (among other things) that their premises were desegregated, promotion was made on merit, underprivileged people were trained and promoted and substantial sums of money given to education, housing and development projects.

This is not the forum to discuss the effectiveness or otherwise of the codes. Suffice to state that it was the Sullivan Code, named after the Rev. Leon Sullivan, which affected most US companies.

Adherence to this code led to large sums in cash, support and equipment being donated for the education of disadvantaged (mostly black) people in South Africa.

Control Data Corporation was a founder signatory of the Sullivan Code and sought to use its considerable expertise with computer-based education to assist needy people in South Africa. In this respect, CDC was following its corporate philosophy expounded by its founder, William Norris, who was strongly committed to the use of corporate recources for social upliftment (see Norris, 1978) wherever his company operated. Norris was especially interested in the problems of South Africa and believed strongly that Control Data had a role in "...promoting equal participation by all people in South African Society..." (CDC Education Company, 1979).

Not surprisingly, this policy was controversial but it led to the establishment of several computer-based educational projects, among them, the one at St Anthonys.

## INTERNATIONAL TRANSFER OF TECHNOLOGY

So it was that in 1979, I found myself charged with the responsibility for introducing a PLATO system at St Anthony's and measuring the effectiveness of the project. Nothing of the sort had ever been attempted before. Computer-based education was an unknown factor in South Africa and appropriate literature, even from the US, was sparse. There were considerable doubts about the feasibility of transferring technology from one setting to another and the cost of a mainframe-based PLATO system was high.

Apart from cost, the biggest concern related to courseware. A major selling point for the PLATO system was the vast mass of published courseware on the system but this all originated in the US. Many educationists expressed concern over the value of such material in a South African context. The teaching of English as second language had emerged as a major need and the existing courseware followed American spellings and grammatical usage practices.

Nevertheless, the advantages perceived for computer-based education - its ability to provide individualised tuition, at any time, in a wide variety of subjects and at the most appropriate level for the individual student - provided a powerful incentive to go ahead with the project. It was argued that given the undoubted need of the body of student users, some CBE would be better than no CBE, even if the courseware was not entirely appropriate for local people. This approach was later vindicated in the report of the South African Human Sciences Research Council (HSRC 1983) on Computers in Education, which recommended that local users do not wait until perfect courseware comes to hand but rather proceed with what is available.

One of the courses considered to offer most potential was the Basic Skills Curriculum. Intended for functionally illiterate school dropouts (ie: people with less that grade 8 equivalency in computation and communication), Basic Skills covered the fundamentals in English reading, language and in Mathematics. Unfortunately, the material was extremely culturally-biased, having apparently been designed for dwellers in US inner-city areas. Many of the lessons used examples from the contemporary US sporting scene and there were numerous references - for instance, to "OJ" or to the "Red Sox". These are totally obscure for non-Americans, even those living in a society blessed (?) by US cultural imperialism through the media of film and TV.

There were other problems. One lesson explained that words could mean different things depending on their context. All well and good, except the example used was "lemon" - a fruit or a dud. The latter meaning was unfamiliar in South Africa. Even more difficult were the confusion between the terms "homophone" and "homonym"; punctuation - exclamation 'points'/marks, 'periods'/full stops; other punctuation idiosyncracies that demand a comma after a conjunction; and the -or/-our suffixes.

So in 1979-80, a South African modification was made to the Basic Skills Curriculum. In its way, this was equally culturally-biased, as typically South African examples were substituted for the American ones. That was a major exercise, deserving of a paper in its own right. However, I would not recommend modifying published courseware unless there is absolutely no alternative. What we ended up with was a non-standard product which was not updated when CDC eventually released an updated PLM-version of the curriculum to replace the somewhat unique router originally used.

## EVALUATION

A comprehensive evaluation of the project was undertaken, which sought to assess the impact of the computers on the St Anthony's population. Of particular interest was the student response to the use of technology. Did they feel the computers really helped them to learn?

From the outset, I rejected a classical research design, feeling that in a real-life situation, there could be no justification for separating adult students into control and experimental groups. From a moral perspective, the students were owed access to whatever they perceived as the best instruction. Accordingly, a qualitative approach was followed, in which a complex reality is assumed and which seeks to gather as much data as possible by such techniques as participant observation, interviews and questionnaires. Research continued from 1981 to 1988, with a vast body of data emerging about the project.

## THE BODY OF QUALITATIVE DATA

What follows in this paper is a selection of student responses to CBE obtained by free response to questionnaires, with some triangulation by interview. The material is published with a view of adding to the body of qualitative data relating to CBE. Although a case study dealing with a unique situation, I trust the data will be of some interest to an international audience of CBE professionals, dealing as it does with the use of educational technology in the development of needy people in a country which has attracted much negative publicity.

## THE PROJECT

Before considering evaluation responses, a description of the St Anthony's project itself is needed to set the scene. When first conceived, the only computer-based education available from the sponsors, Control Data, was the on-line PLATO system. Initially, St Anthonys used 16 on-line terminals located in a custom designed learning centre. This configuration lasted from the inception of the project in 1981 until 1984. It proved very popular with students and staff at St Anthonys, who particularly enjoyed the ability to select lessons from the huge array on the central PLATO system. The problem with this approach, however, was the cost of the system. Running at the time in excess of $100,000/year, this was far more than could be obtained by even the most ingenious fund raiser. There were ambitious plans for the centre to become self-funding by selling courseware in technical training subjects to local industry. Unfortunately, these never succeeded, leading to the realisation that the sort of person who could run a learning centre was different from the sort of person who could sell training courses to industry.

With cost as a major concern but not wanting this project to collapse, CDC responded in 1984 by donating 10 CDC110 microcomputers, plus courseware to St Anthonys. These replaced the previous on-line system. An immediate logistical issue centred around using 10 computers instead of 16. Fortunately this was never a major problem, although using courseware on floppy disk was. The courses which the students used the most were English (the same "American" Basic Skills material described above, now modified to remove some of the points of criticism) and the CDC High School Skills series. Also Mathemetics, biology, physical science, computer programming and word processing. All were available on the 8 inch floppy disks used by the CDC110s and several sets were ordered. The difficulty came in judging just how many to get: one set of each per computer was impractical and expensive and it took some time before the optimum setup was arrived at.

From a resources perspective, this is essentially how the project remains to this day, although the 6-year old 110s are showing their age. Parts for the Viking terminals are becoming harder to obtain, as is the 8" disk courseware. I hope an LAN will be put in one day to replace the 110s but that will be a story for another meeting.

## STUDENTS

Samples of the student users taken over the years showed them to be predominately young adult, with more than half aged between 21 and 30 years. It is interesting to note, however, that some learners were older than 50 years.

Most attended classes in the evenings. They were doing a variety of different jobs from manual labour to teaching. Some were unemployed. Many students were doing part-time academic courses in the evenings at St Anthonys and these used the computer courseware to supplement their traditional lectures. There was no compulsion for such students to use the computers. From time to time, the staff at the PLATO centre told students what was available and invited them to see for themselves. Thereafter, word of mouth among the students ensured a steady flow of users.

St Anthonys is situated next door to a major gold mine employing thousands of workers, most of whom came from surrounding states. Hundreds of these study at the centre. One man told me he had heard about the PLATO centre from a relative in Malawi, who had used it himself while employed on the mine and recommended that the informant do likewise. Word of mouth was proving to be powerful advertising!

Apart from academic subjects, courses were also offered in word processing, keyboarding and BASIC programming. These attracted a somewhat different group of students. All had completed 12 years of school, some were unemployed and seeking new skills acquired at the centre to get them jobs. These students paid a nominal course fee to the PLATO centre.

Since 1986, a new, full-time group appeared. Called "Project Matric", these were students who had left the formal school system for one or other reason but who were trying to complete their schooling. Project Matric was in reality, a full-time private school. It is interesting to note that although black students tended to reject the education provided for them through the government-controlled school system, centres such as St Anthonys or other private schools were readily accepted. The people were not rejecting learning per se. They were rejecting learning through a system which they regarded as politically tainted. This made the provision of learning aids such as PLATO in non-formal centres which were ideologically acceptable, even more vital.

## STUDENT RESPONSES TO CBE

When considering the effectiveness of PLATO CBE in the St Anthony's context, considerable store was placed on the reaction of students to the system. Given the need for supplementary education of the target population and the socio-political constraints under which most laboured, it is important to know whether the offer of CBE is perceived by the users as being of any value. This section records data on student responses to PLATO, taken from 251 randomly allocated questionnaires. These included free-response sections in which the respondents could write about things which they liked or disliked about the computers.

As part of the aim of this paper is to communicate to the audience a feel for what the study is all about, a formal, objective description is not always adequate. The following quotations are an effort to convey to the reader some of the flavour of the St Anthony's project. Accordingly, they are taken verbatim from the user responses and include the original grammar and spellings of students for whom English is a second language. Taken together, these comments form a fascinating picture of the reactions of this group of adult students to an innovative method of learning.

First, things people do not like about the computers:

There is nothing I do not like about using the computer!

The only thing that I do not like on the computer is that some of the subject are not there. I would like to have all my lessons given on the computer especially the difficult lessons like history and geography [this is hardly criticism of CBE]

It will cause more poverty to some who cannot use it as there will be no jobs for them . . . a standard 8 [10th grade] pupil must also be able to use it [presumably, those who are able to use it get an unfair advantage over those who are not].

If I use the computer more than two hours I become strenious feel some headache

I am against being taught things that wouldn't be asked in the exams. As private students I would not like to waist a minute on an unnecessary thing because I learn to pass the exams first and enlarge my knowledge [students write a public examination for their high school certificate and the syllabus is, regrettably, all important in many schools, as this student's remarks testify].

When I am certain the answer should read say for example Sulphur or 40 km/h and the computer still says no. And I can't go on with the particular question or change to a certain chapter. By pressing Shift-Stop and signing on again.

It gives the very question again.

I don't like to use the computer unless I have read the chapter on my own before coming to the computer The problems are too easy for a Std 10 [12th grade] student which is undiserable for the above mentioned level and it does not give "thought provoking questions" or problem which we are encountering during exams period

It must not ask so many questions because one spend long time straggling on one question [a reference to the lengthy PLM tests in some of the courses]

I prefare to study in my books than to use computer. By using computer I while [waste] a long time by pressing all that bartens [buttons].

To me it's easy to read my books than to use a computer.

Suppose you are not well to do with a computer nor a subject you may waste time of your work and end up nowhere in the class if you are all by yourself at a computer centre.

One of the things that I do not like is the fact that the computer is at times not able to give a clear explaination when I need it. It is at this time that I need my teacher. [this student also remarked that teachers send him to sleep - teachers do have their uses, it seems]

It has some American words like "thru".

If it gave you an answer it won't explain how.

I have no chance to ask a question which I do not understand.

Sometimes it makes you lazy to think [the meaning of this was not clear]

While I am using a computer I find difficulty in following some explainations.

Sometimes, in the middle of an important program, there would be a power failure and this would result in the whole program being lost [programming student].

It spoils eyes. It also spoils teachers if you come across a certain problem they will refer you to the computer [computer as an aid for a lazy teacher?]

At times when doing problems, I wish I can ask direct questions to the computer forgetting that it cannot answer directly as a teacher would.

The last word under "things you do not like" is a variation of the comment which began the section. It comes from one of the many students who had nothing adverse to say at all:

I like everything about the computer

More users made positive comments about the computers than negative. Under "Things people like about using the computer":

The computer is a standardised and comprehensive method of learning. Furthermore, I like to learn on my own, instead of having another person to explain to me. This would make things much more complicating. The main thing I like is that it is a very unorthodox method of learning.

I like using the computer because it explain everything at the same time.

It helps me in gaining the speed. It encourages one to work fast and on her own [secretarial student].

I am very much impressed about using the computer.

In similar vein:

I like using the computer because it helped me to improve my speed very much. Thank you.

An interesting insight was expressed by another student:

The computer is a very fair, faithful, honest and reliable teacher. It doesn't hesitate to tell you exactly what you are doing. So whatever the computer tells you is no lie. What I like more about it there is no student that will say, "The computer hates me that's why I didn't do well."

A very long response came from a student who travelled weekly from Pretoria (a round trip of about 100 miles) to use the computer and attend classes. He crossed out the section on "things you do not like" with the remark, "This statement does not hold" and wrote:

Unlike a teacher in class, the computer will challenge your reasoning ability as an individual. Because of time factor, a teacher in class cannot spend enough time to each student whereas a computer is capable to do so. A teacher in class can wast your time by putting more emphasis on topics I understand whereas with a computer, I can bypass such topics. in a class, one may be shy or sometimes afraid to attempt challenging questions because of the liklywood of giving answers which might be embarrassing

Other students wrote:

I like the computer because it explains every thing very clear and its makes me to know some of the chapter which I was confused when I was thought [taught] by my teacher

Using the computer is very helpful to me because after every section it gives me a test to try how I am progressing with the lesson . . . in this way no student can skip to another lesson without having understood the previous.

Even learning how to use the machines its really fun to me

That the computer is personal and sometimes, even regarded as being quite like a person may be seen from some of the responses. These - and those in the section above - contrast with the few respondents who felt the computer lessons did not explain problems clearly:

The computer is just as good as a teacher inaway that when you are working with it, you feel as if you are talking to someone. . . You can spend hours on it unlike with a teacher standing in front of you that makes you go to sleep. The computer makes you active because you are always working. [This is the student whose remark that he needs his teacher to explain some things which are not clear, is recorded above]

By using the computer I find it interisting and helpfull because the lecture [computer lesson] give us assignments and makes us do them, after that he gives us answers

It is a great friend that shares problems and which we manage to solve in a reasonable time

Computer is very kind to a human being because it is patient. . . you can do one question or one thing a thousand times

A computer is a great source of help to a student [the respondent had written, then crossed out "partner"] because it has patience and it explains everything in such a way that even those students that are not brilliant understands everything

And even: Computer is my best friend because it gives me a good lessons to learn, it teaches me more easily than a particular Teacher. Furthermore, Computer gave me the way of speaking English etc [if not too much skill in writing it]

Students saw various benefits in using the computer:

Those [students] who are using computer they even pass their examinations.

It is easy to find a job when you know how to you use a computer [important for students who are worried about race prejudice in the workplace] I also like the fact that the computers are (in a nutshell) the future. I hope to find a job using a computer because I like it so much

It gives you the opportunity to discover for yourself

It activates my brains

Working in silence is also something good, not like the tapping of the typewriters.

It will be better if we use computer to [for] everything

Will gear me up for the up and coming computerised life in future [many students felt that knowledge of computers offered them job opportunities]

I like computer because there is too many facts in it [typical mother-tongue transfer into English - ignore "too"]

I like to do everything which the computer can do

My lessons are very easy when I use computer. Problems in mathematics and other subjects are solved more easily in the computer rather than using your thoughts [something which the system developers would, no doubt, be interested to hear].

I like to use the computer even on Saterdays on my spare time

Several students made revealing comments relating to their problems as part-time learners, especially the relationship with teachers:

Sometimes I do not have a chance to study at home or I found difficult to learn on my own, without a teacher. I found a computer very useful in such a way that if the teacher is boring you may just forget about him/her and use the computer.

Computer help us to increase our knowledge when the teachers are behind the work and to understand more clearly if the teachers teaches us about something which we have already treated in the computer.

I seem to get even somethings the teacher as per mistake might have omitted.

It explain more carefull than a teacher sometime you wont understand him

I like to use the computer because it helps me a lot about problems which I didn't understand well in class and it is more to the point.

I learn more than at class. Some of the things that I learn in the computer are not there at class and computer is easy to be understood.

I like computer because it helps me in many things which I don't understand from our English teacher. And I use it the way I feel. Nobody is pushing when I'm busy with it.

Two comments have been chosen to conclude this section of the paper. Each in its own way, does much to illuminate the students' feelings towards computer-based education:

> I am always happy when I am using it. It can do wonders for a man.

The second and really touching remark came from a middle-aged, 12th grade part-time student who gave his occupation as "tea boy". He stated simply:

> It is a boon to mankind.

## CONCLUSIONS

The above comments form a small part of a far more comprehensive evaluation of the St Anthony's PLATO project (Wolfson 1989). This shows that CBE has a valuable role to play in this sort of environment. It does not seek to compare CBE with other media but does show that with an educationally impoverished and politically repressed target population where the demand for learning is high, students regard CBE as useful in their individual efforts at self-improvement. Triangulation by interview indicated that students considered PLATO as an essential component in the St Anthony's learning offerings and were horrified to be asked if it should be discarded. From the donors' perspective, their investment was shown to be worthwhile with the system being seen as providing in a small way, upliftment to a disadvantaged people who sorely needed it. In this respect, St Anthony's has served as a model for other CBE projects in Southern Africa which are also playing their part in the struggle.

## A LAST WORD

The St Anthony's PLATO Project described in this paper was made possible by the social responsibility practices of Control Data Corporation and its South African subsidiary. In November 1988, CDC bowed to pressure from various sources and like all the other US-based high tech multinational corporations, sold its operations in South Africa. The funding for education projects which was provided in terms of a general corporate commitment to social responsibility, or to a particular Code of Conduct, has accordingly dried up. St Anthonys and other bodies doing similar work are finding that money to help underprivileged people is in very short supply since the US companies left.

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# A COMPUTER-VIDEO INTERACTIVE SYSTEM FOR BEHAVIORAL RESEARCH

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## ABSTRACT

A computer-video interactive system is described that has a custom built interface connecting the computer and the video cassette recorder (VCR) through the parallel port of an IBM compatible microcomputer. This interface allows the computer to control the functions of a VCR that has a 34 pin remote controller (most Panasonic NV and AG series). Also, several computer programs are listed that exemplify the operation of this interface.

## INTRODUCTION

The purpose of this paper is to describe a behavior recording system that has the capability of recording, storing and analysing coded behaviors that can be efficiently recalled on videotape. The general methodology that is illstrated in Figure 1 can be used to describe any behaviour observation period in which two records of the same behavior are collected. Firstly, the experimenter codes and enters the pertinent behaviors into a microcomputer (see Franks, Johnson and Sinclair, 1988; for a description of such a computer aided recording instrument). This coded behavior is then stored along with the time of its occurrence, thus setting up an array of time-data pairs. Secondly, a videotaped recording of the observed behaviors is also taken. In addition to recording the visual image (video track) and sounds (audio track channel 1) of the behavior the computer sends out a time pulse that is recorded onto the audio track channel 2 of the videotape. This method of video indexing will allow for accurate search control when the behaviours are being recalled after the observation period. (See Clarke and Ellgring, 1983, for a detailed discussion of frame-accurate video indexing). At the commencement of the behavior observation period the experimenter then computes various analyses of the coded behaviors. A menu driven program would best serve this investigative process and enable the experimenter to cross-reference specific categories of behaviors. The mechanism whereby the experimenter can now recall on videotape any or all selected behaviors is described in the following section of this paper.

### Design Constraints

Since the nature of the application was mainly fieldwork (i.e. recording behaviors in ecological settings), it was important that the interface could be used in conjunction with a portable or laptop computer. This requirement eliminated the possibility of designing firmware that would be resident within the motherboard of the computer. The alternative, therefore, was to use the parallel port of the computer and in doing so maintain its use as an interface for any additional data input device that may be needed to record the coded behaviors. As can be seen in Figure 1 the data input device that has been described here is a touch sensitive digitization tablet that uses the parallel port for data entry. A description of such a device can be found elsewhere (Franks, Wilson and Goodman, 1987; and Franks, Johnson and Sinclair, 1988) and will not be dealt with here.

In summary, it was necessary to accommodate the following design constraints. (1) The whole interactive system should occupy a single parallel

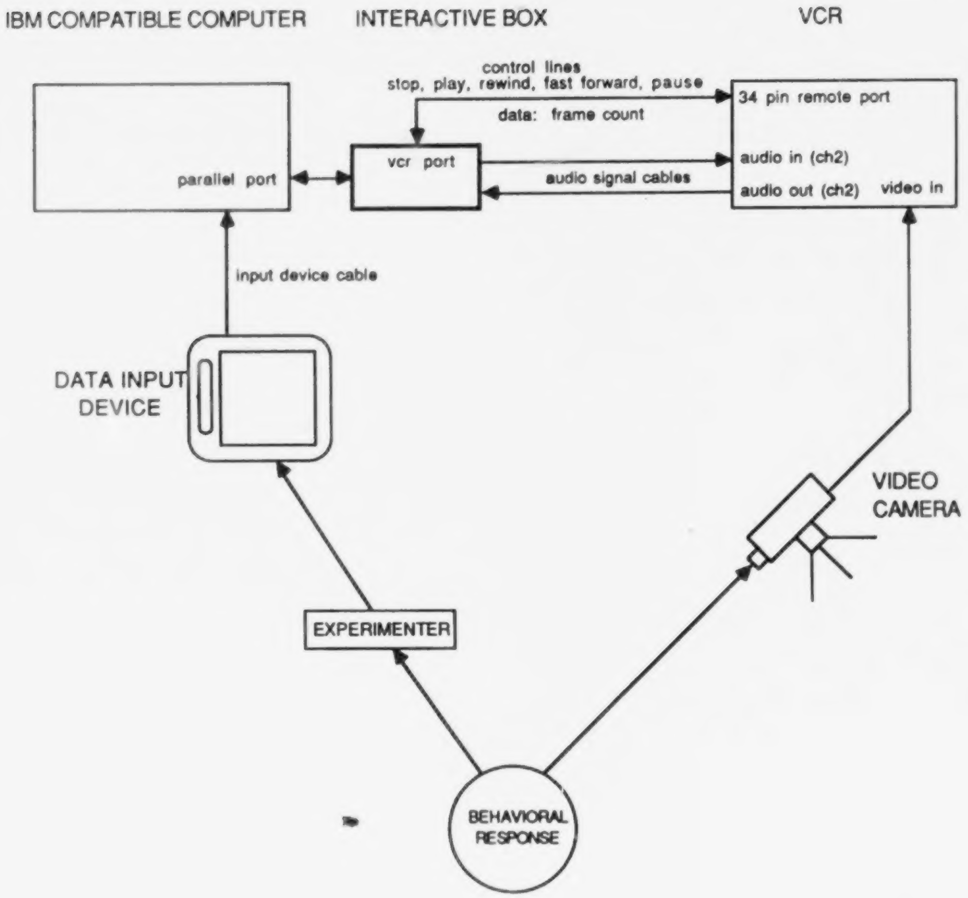
IBM COMPATIBLE COMPUTER
INTERACTIVE BOX
VCR
control lines
stop, play, rewind, fast forward, pause
34 pin remote port
data: frame count
vcr port
audio in (ch2)
parallel port
audio signal cables
audio out (ch2)
video in
input device cable
DATA INPUT
DEVICE
VIDEO
CAMERA
EXPERIMENTER
BEHAVIORAL
RESPONSE

Figure 1 An illustration of the method whereby two simultaneous records of behaviour can be collected.

port location. (2) This interactive system should allow other devices input to the parallel port. Therefore the system has a limited number of connections. (3) The five main VCR functions, (i.e. STOP, PLAY, REWIND, FAST-FORWARD AND PAUSE) must be available for computer control.

(4) An audio time code signal has to be transmitted from the computer to the videotape (audio track channel 2), and on playback the audio time code must be received and read by the computer (5) The frame count signal must be read by the computer during the VCR functions REWIND and FAST-FORWARD, in order to keep account of the position of the videotape.

### Parallel Port

The parallel port has three types of signal lines. The first is comprised of eight data lines that are used to send eight bit codes to the printer. These are + 5 volt digital logic. The second set is made up of five status lines that are used to communicate to the printer such information as, "out of paper", "busy", etc. These five lines are of mixed logic, some of the signals are inverted upon entering the computer, some are not. Finally, the third set of signal lines are four control lines that are of inverted logic. These lines have to be pulled to ground to activate the event. One example of this is the "Data Strobe" which is pulled to ground to strobe the eight data bits into the printer. This was used to control the STOP function on the VCR.

### Computer-Video Interface

The circuit diagram of the computer-video interface is illustrated in Figure 2. The four control lines from the computer are the same logic system as the VCR controls (this is the case for most Panasonic NV and AG series VCRs) and therefore were connected directly to the functions PLAY, REWIND, FAST-FORWARD and STOP. The data input devices (it is possible to have two devices) and audio time code signal take up all but one of the remaining data lines. This line is then used to switch on a 2N2222 transistor, which in turn is connected as an inverter and used to activate the PAUSE function on the VCR. Therefore by sending a high logic signal to the various control lines the apropriate action can be activated.

After the two input device signal lines were accounted for there was only one status or input line remaining, yet there were still two signals that needed to be sent to the computer, the pause count signal and the audio time code from the videotape. Since the frame count is only used during the REWIND and FAST-FORWARD VCR operation, and the audio time code only during PLAY, a small relay was used to select one of the two signals. When the VCR is in the PLAY mode, the PLAY display line (pin 24 of the 34 pin remote controller of the VCR) is pulled to ground. The relay was connected to a 12 volt line (pin 34) and the PLAY display line. Thus the relay was activated whenever the VCR was playing and so the audio time code was carried to the input line only during play. The 1N4005 diode was used to neutralize the voltage spikes of the relay coil when the coil was deactivated. The operation of the 324 operational amplifier was similar to that of the IBM computer board's 741, except that the 324 requires +12 volts as opposed to the 741, that needs +5 and -5 volts.

### SOFTWARE PROGRAMS

The program using the interactive box must have the port location specified before any operation can begin. If the wrong port is specified and there is a printer attached to the parallel port, the printer will print some random characters each time the VCR'S STOP function is activated (data will be "strobed" into the printer). The parallel printer ports for the IBM PC and all true compatibles are found at only three port locations.

LPT1
data: port 888 or $378 hexadecimal
status: port 889 or $379
control: port 890 or $37A

LPT2
data: port 632 or $278
status: port 633 or $279
control: port 634 or $27A
On monochrome card
data: port 956 or $3BC
status: port 957 or $3BD
control: port 958 or $3BE

Two of the first lines in the program should read (in TURBO PASCAL):

```
PORT [CONTROL_PORT] := 04;
PORT [DATA_PORT]    := PORT [DATA_PORT]
OR $7F;
```

The first line turns all the VCR functions off, the value of 4 needed to deactivate the non-inverted REWIND function. The second line deactivates the PAUSE function by forcing the most significant bit to go low, turning the 2N2222 transistor off.

The various VCR function calls will be listed below with specific descriptions of how they work and an explanation of the extra testing to avoid the time code read errors.

### [A] Program for placing time code on video tape

```
PROGRAM TIME_DUB;
VAR
 SECOND_COUNT, NOW_TIME, OLD_TIME :INTEGER;

PROCEDURE PRESS_ALL_PLAYS;

(*  Activate the play function at all 3 possible parallel ports *)

BEGIN
   PORT[ $37A ] := 02 + 04; (* activate play   (02)           *)
   PORT[ $27A ] := 02 + 04; (* and keep the rewind off (04) *)
   PORT[ $3BE ] := 02 + 04;

   DELAY (100 );

   PORT[ $37A ] := 04;(* deactivate the play, leave rewind off *)
   PORT[ $27A ] := 04;
   PORT[ $3BE ] := 04;
END;


PROCEDURE PRESS_ALL_STOPS;

   (* Activate the stop function at all 3 possible paralleL ports *)

BEGIN

   PORT[ $37A ] := 01 + 04; (* activate stop ( 01 )         *)
   PORT[ $27A ] := 01 + 04; (* and keep the rewind off (04)*)
   PORT[ $3BE ] := 01 + 04;

   DELAY( 100 ) ;

   PORT[ $37A ] := 04; (* deactivate the stop, rewind off.*)
   PORT[ $278 ] := 04;
   PORT[ $3BE ] := 04;
END;


PROCEDURE PRESS_ALL_PAUSES;

(* Activate pause on data ports, do not change other bits *)

BEGIN
   PORT[ $378 ] := PORT[ $378 ] OR $80;  (* turn on pause *)
   PORT[ $278 ] := PORT[ $278 ] OR $80;
   PORT[ $3BC ] := PORT[ $3BC ] OR $80;

   DELAY( 100 );


   PORT[ $378 ] := PORT[ $378 ] AND $7F;  (* turn off pause *)
   PORT[ $278 ] := PORT[ $278 ] AND $7F;
   PORT[ $3BC ] := PORT[ $3BC ) AND $7F;
END;


FUNCTION CLOCK_SECONDS :INTEGER;

(* This is INTERRUPT 33 ( $21 ), FUNCTION 44 ( $2C )
   The second value of the IBM REAL TIME CLOCK is returned.
   This value changes once each second . *)

TYPE
  REGPACK = RECORD
             AX,BX,CX,DX,BP,DI,SI,DS,ES,FLAGS :INTEGER;
             (* 16 BIT BYTES *)
           END;

VAR
  RECPACK : REGPACK;

BEGIN
   RECPACK.AX := 44 * 256; (* HIGH 8 BITS HAS TO BE 44
                                  DECIMAL *)
   INTR ( 33,RECPACK );

   (* the hours is found from CX DIV 256
        minutes is found from CX MOD 256
        seconds is found from DX DIV 256
   the hundredths of seconds is found from DX MOD 256  *)

   CLOCK_SECONDS := RECPACK.DX DIV 256;
END;
```

```
PROCEDURE RECORD_TO TAPE ( SECOND_COUNT :INTEGER);

(*    Sends out the audio signal time code.  The line is raised
      high, four 1ms pulses are sent out, a 0.5 ms marker pulse,
      then the 15 bits of the time.  A "1" is 1ms long, "0" is
      0.5 ms. A final "0" is sent to return the line to ground. *)

VAR
    I, BIT ;INTEGER;

BEGIN
    PORT[ $378 ] := PORT[ $378 ] OR $40;        (* raise signal line *)
    PORT[ $278 ] := PORT[ $278 ] OR $40;        (* on all parallel ports *)
    PORT[ $3BC ] := PORT[ $3BC ] OR $40;

    FOR I := 1 TO 46 DO;                        (* delay one millisecond)

    PORT[ $378 ] := PORT[ $378 ] XOR $40; (* invert signal *)
    PORT[ $278 ] := PORT[ $278 ] XOR $40;
    PORT[ $3BC ] := PORT[ $3BC ] XOR $40;

    FOR I := 1 TO 46 DO;                        (* delay one millisecond *)

    PORT[ $378 ] := PORT[ $378 ] XOR $40; (* invert signal *)
    PORT[ $378 ] := PORT[ $278 ] XOR $40;
    PORT[ $3BC ] := PORT[ $3BC ] XOR $40;

    FOR I := 1 TO 46 DO;                        (* delay one millisecond *)

    PORT[ $378 ] := PORT[ $378 ] XOR $40; (* invert signal *)
    PORT[ $278 ] := PORT[ $278 ] XOR $40;
    PORT[ $3BC ] := PORT[ $3BC ] XOR $40;

    FOR I:= 1 TO 20 DO;                         (* delay one half
                                                 millisecond *)

    PORT[ $378 ] := PORT[ $378 ] XOR $40;. (* invert signal *)
    PORT[ $278 ] := PORT[ $278 ] XOR $40;
    PORT[ $3BC ] := PORT[ $3BC ] XOR $40;


   FOR BIT := 1 TO 16  (* only 15 bits available *)
   DO BEGIN
      IF ODD (SECOND COUNT)             (* look at least significant bit *)
      THEN FOR I := 1 TO 43 DO  (* if a "1" delay one millisec *)
     ELSE FOR I := 1 TO 18 DO; (* else delay 1/2 millisec *)

      PORT[ $378 ] := PORT[ $378 ] XOR $40;     (* invert signal *)
      PORT[ $278 ] := PORT[ $278 ] XOR $40;
      PORT[ $3BC ] := PORT[ $3BC ] XOR $40;

      SECOND_COUNT := SECOND_COUNT SHR( 1 ); (* shift all bit right
                                                 one spot *)
   END;

END;


BEGIN  (* TIME DUB PROGRAM *)

    PRESS_ALL_STOPS;  (* deactivate the rewind function *)

    CLRSCR;
    WRITELN('                    DUB AUDIO TIME CODE ONTO VIDEO TAPE');
    WRITELN;
    WRITELN;
    WRITELN(  'Complete the hook up of the VCR.  Once all is ready,
                  press either the');
    WRITELN;
    WRITELN('VCR <RECORD> button to record the audio time code
                                 and video camera image, or');
    WRITELN;
    WRITELN('VCR <AUDIO DUB> button to dub the audio time code
                              onto a pre-recorded tape,');
    WRITELN;
    WRITELN('while you depress the computer <RETURN> key.');
    WRITELN;
    WRITELN('      Only ten minutes of audio time code will be
                  dubbed.');

    WRITELN;
    READLN;

    CLRSCR;
    WRITELN('              DUBBING THE CODE ONTO THE VIDEO TAPE');

    PRESS_ALL_PLAYS;

    DELAY( 2000 ); (* delay while VCR loads up *)
    OLD_TIME := CLOCK_SECONDS;

    FOR SECOND_COUNT := 0 TO 600
    DO BEGIN

       REPEAT
             NOW_TIME := CLOCK_SECONDS;
       UNTIL NOW_TIME <> OLD_TIME;
       OLD_TIME := NOW_TIME;
       RECORD_TO_TAPE( SECOND_COUNT  );
       GOTOXY( 10,10 );
       WRITELN('TIME IN SECONDS:' ,SECOND_COUNT);

    END;

    PRESS_ ALL_STOPS;

    WRITELN;
    WRITELN('Ten minutes completed');

END.
```

[B] Program to search and play a section of videotape.

```
PROGRAM AUTOPLAY;
CONST
    LEAD = 10;
    TAIL = 10;
VAR
    Data_Port, status_port, control_port, present_position,
    Destination : INTEGER;

PROCEDURE PRESS_STOP;
BEGIN
    PORT[ CONTROL_PORT ] := $01 + $04;     (* PRESS THE STOP BUTTON *)
    DELAY( 100 );                          (* 100 MS *)
    PORT[ CONTROL_PORT ] := $04;           (* RELEASE THE BUTTON *)
END;

PROCEDURE PRESS PLAY;
BEGIN
    PORT[ CONTROL_PORT ] := $02 + $04;     (* PRESS PLAY *)
    DELAY( 100 );                          (* 100 MS *)
    PORT[ CONTROL_PORT ] := $04;           (* RELEASE *)
END;

PROCEDURE PRESS_REWIND
BEGIN
    PORT[ CONTROL_PORT ] := $00;     (* PRESS REWIND *)
    DELAY (100);                     (* 100 MS *)
    PORT[ CONTROL_PORT ] := $04      (* RELEASE *)
END;

PROCEDURE PRESS_FAST_FORWARD;
BEGIN
    PORT[ CONTROL_PORT ] := $08 + $04;     (* PRESS FF *)
    DELAY( 100 );                          (* 100 MS *)
    PORT[ CONTROL_PORT ] := $04;           (* RELEASE *)
END;

PROCEDURE PRESS_PAUSE;
BEGIN
    PORT[ DATA_PORT ] := PORT[ DATA_PORT ] OR $80; (*PRESS PAUSE*)
    DELAY( 100 );                                         (* 100 MS *)
    PORT[ DATA_PORT ] := PORT[ DATA_PORT ] AND $7F (* RELEASE *)
END;

PROCEDURE READ_FROM_TAPE( VAR SECOND_COUNT :INTEGER );

(* READS AN AUDIO TIME CODE VALUE. DOES SOME COMPARISONS:
   1)   IF THE READ VALUE IS ONE GREATER THAN THE VALUE PASSED TO ROUTINE THROUGH THE
          SECOND_COUNT VARIABLE THEN THE NEW VALUE IS PASSED BACK.

   2)   IF READ VALUE IS NOT ONE GREATER THAN THE PASSED VALUE THEN THE ROUTINE READS TWO
          TIME CODES UNTIL THE TWO ARE WITHIN ONE VALUE AND PASSES THE GREATER VALUE BACK
          TO THE CALLING ROUTINE.

   3)   IF NO AUDIO SIGNAL IS FOUND FOR MORE THAN 2.5 SECONDS THEN THE ROUTINE RETURNS -1.

NOTE:   AN INVALID AUDIO SIGNAL OR WRONG COMPUTER SPEED (RE: TURBO  MODES) WILL
          PERMANENTLY "HANG" THIS PROCEDURE.*)


VAR
    NOW, PAST, COUNT :INTEGER;

FUNCTION AUDIO_TIME :INTEGER;
(* RETURNS A TIME VALUE OR -1 IF NO SOUND AT ALL FOUND *)

VAR
    SECOND, COUNT, OLD, NEW, BIT :INTEGER;
    VALUE :ARRAY[ 1..16 ] OF BYTE;

LABEL
    RESTART, ABORT;
```

```
BEGIN
  NEW := PORT[ STATUS_PORT ] AND $80; (* LOOK AT BIT #7 OR MSB *)

  RESTART:

  REPEAT

    REPEAT
      COUNT := 0;
      OLD := NEW;
      LINE ( $FA );  (* DISABLE INTERRUPTS )

      REPEAT
        COUNT := COUNT + 1;
        NEW := PORT[ STATUS_PORT ] AND $80;
      UNTIL ( OLD <> NEW ) OR ( COUNT > 32000 );

      IF COUNT > 32000 THEN GOTO ABORT;  (* NO AUDIO FOUND *)

    UNTIL (COUNT > 10 ) AND ( COUNT < = 20 ); (* loop until valid
                                                       lms pulse *)

    REPEAT
      COUNT := 0;
      OLD := NEW;
      INLINE ( $FA );  (*DISABLE INTERRUPTS *)

      REPEAT
        COUNT := COUNT +1;
        NEW := PORT[ STATUS_PORT ] AND $80;
      UNTIL ( OLD <> NEW ) OR ( COUNT > 32000 );

    UNTIL ( COUNT < = 10 ) OR ( COUNT > 20 ); (* non 1 ms loop *)

    IF COUNT > 32000 THEN GOTO ABORT;  (* NOT AUDIO FOUND *)

  UNTIL (( COUNT > 4 ) AND ( COUNT <= 10 )); (* 0.5 MS PULSE
                                                        IS A MARKER *)

  INLINE ( $FA );  (* DISABLE INTERRUPTS *)

  FOR BIT := 1 TO 15 (* NO 16TH BIT *)
  DO BEGIN
    COUNT := 0;
    OLD := NEW;
    REPEAT
      COUNT := COUNT + 1;
      NEW := PORT[ STATUS_PORT ] AND $80;
    UNTIL OLD <> NEW;

    IF ( COUNT < 6 ) OR ( COUNT > 24 ) THEN GOTO RESTART;

    VALUE[ BIT ] := COUNT;
  END

  INLINE ( $FB ); (* RE-ENABLE INTERRUPTS *)

  SECOND := 0;
  COUNT :=1;

  FOR BIT := 1 TO 15
  DO BEGIN
     IF VALUE[ BIT ] > 13
     THEN SECOND := SECOND + COUNT:
     COUNT := COUNT * 2;
  END;

  ABORT : IF COUNT > 32000 THEN SECOND := -1;

   AUDIO_TIME := SECOND;
END;


BEGIN
   NOW := AUDIO_TIME;

  IF NOW = SECOND_COUNT + 1
  THEN SECOND_COUNT := NOW
  ELSE BEGIN
    REPEAT
      PAST : = NOW;
      NOW := AUDIO_TIME;
    UNTIL ( NOW = PAST + 1)  (* READ UNTIL VALID TIMES *)
       OR ( NOW = -1      )  (* OR NO SIGNAL AT ALL *)

    SECOND_COUNT := NOW;

  END;
END;
```

```
PROCEDURE GO_TO_POSITION(     DESTINATION      :INTEGER;
                          VAR PRESENT_POSITION :INTEGER );
VAR
  FRAME_COUNT, I :INTEGER;

BEGIN
  IF DESTINATION < PRESENT_POSITION THEN PRESS_REWIND;
  IF DESTINATION > PRESENT_POSITION THEN PRESS_FAST_FORWARD;

  FRAME_COUNT := 0

  WHILE DESTINATION<> PRESENT_POSITION
  DO BEGIN

    REPEAT
    UNTIL ( PORT[ STATUS_PORT ] AND $80 ) = 0; (* WAIT FOR A
                                                  FRAME PULSE *)

    REPEAT
    UNTIL ( PORT[ STATUS_PORT ] AND $80 ) = > 0  (WAIT UNTIL
                                                     PULSE PASSES *)

    FRAME_COUNT := FRAME _COUNT + 1;

    IF FRAME_COUNT >= 30                     (* 30 FRAMES A SECOND *)
    THEN BEGIN
      IF DESTINATION < PRESENT_POSITION
      THEN PRESENT_POSITION := PRESENT_POSITION -1
      ELSE PRESENT_POSITION := PRESENT_POSITION +1
      FRAME_COUNT := 0
    END
  END;

  PRESS_STOP;

END;


PROCEDURE PLAY_TO_POSITION(     DESTINATION      :INTEGER;
                                TAIL             :INTEGER;
                            VAR PRESENT_POSITION :INTEGER );

VAR
  SECOND_COUNT :INTEGER;

BEGIN
  PRESS_PLAY;
  DELAY (2000);

  REPEAT
    READ_FROM_TAPE( PRESENT_POSITION );
  UNTIL ( PRESENT_POSITION >= DESTINATION )
     OR ( PRESENT_POSITION  = - 1 );

  IF PRESENT_POSITION <> -1
  THEN BEGIN
    SOUND ( 1000 );  (* EVENT BEEP *)
    DELAY ( 100 );
    NOSOUND;

    REPEAT
      READ_FROM_TAPE ( PRESENT_POSITION );
    UNTIL ( PRESENT_POSITION >= DESTINATION + TAIL)
       OR ( PRESENT_POSITION  = -1);

    PRESS_PAUSE;
    DELAY ( 3000 );
  END;

  PRESS_STOP;
END;


PROCEDURE FIND_INTERACTIVE_BOX( VAR PRESENT_POSITION :INTEGER);
VAR
  TRY :INTEGER;

BEGIN
  CLRSCR;

  PORT[ $378 ] := 0;  (* CLEAR ALL DATA PORTS FOR PAUSE *)
  PORT[ $37A ] ;= 4;  (* AND CONTROL PORTS FOR REWIND *)
  PORT[ $278 ] := 0;

  PORT[ $27A ] := 4;
  PORT[ $3BC ] := 0;
  PORT[ $3BE ] := 4;

  WRITELN('        INTERACTIVE CONTROL BOX SEARCH')
  WRITELN;
  WRITELN;
  WRITELN( 'Complete the hook up of the interactive box and VCR.
              When completed');
  WRITELN;
  WRITELN ('PRESS <RETURN> to start the automatic parallel
                                           port search.');
  WRITELN;
  READLN;

  REPEAT
    TRY := 1;
    REPEAT

      IF TRY = 1
      THEN BEGIN
        DATA_PORT := $378;
        WRITELN;
        WWRITELN('Searching parallel port LPT1');
      END;


      IF TRY = 2
      THEN BEGIN
        DATA_PORT := $278;
        WRITELN;
        WRITELN('Searching parallel port LPT2');
      END;

      IF TRY = 3
      THEN BEGIN
        DATA_PORT := $3BC;
        WRITELN;
        WRITELN('Searching parallel port on MONOCHROME CARD');
      END;

      STATUS_PORT  := DATA_PORT + 1;

      CONTROL_PORT := DATA_PORT + 2

      PRESS_PLAY;

      DELAY ( 1000 );

      READ_FROM_TAPE( PRESENT_POSITION );

      PRESS_STOP;

      IF PRESENT_POSITION = -1 THEN TRY := TRY + 1;

    UNTIL ( PRESENT_POSITION <> -1 ) OR ( TRY = 4 )

    IF PRESENT_POSITION = -1
    THEN BEGIN
      SOUND( 1000 ); DELAY( 100 ); NOSOUND; DELAY( 50 );
      SOUND( 1000 ); DELAY( 100 ); NOSOUND; DELAY( 50 );
      SOUND( 1000 ); DELAY( 100 ); NOSOUND; DELAY( 50 );

      WRITELN;
      WRITELN( 'Interactive box not found, or no audio signal
               detected, please correct and press');
      WRITELN('<RETURN> to search again').
      READLN;
    END
    ELSE BEGIN
      SOUND( 1000 ); DELAY( 500 ); NOSOUND;
      WRITELN;
      WRITE('Interactive box found pluggged into parallel
              port configured as');

      IF DATA_PORT = $378 THEN WRITELN('LPT1.');
      IF DATA_PORT = $278 THEN WRITELN('LPT2.');
      IF DATA_PORT = $3BC THEN WRITELN('Monochrome Port.');
      DELAY( 3000 );
    END
  UNTIL PRESENT_POSITION <> -1;
END;

BEGIN
  FIND_INTERACTIVE_BOX( PRESENT_POSITION );

  REPEAT
    CLRSCR;
    WRITELN(       '    EXAMPLE TAPE SEEK AND PLAY  ');
    WRITELN;
    WRITELN;

    WRITELN('  PRESENT POSITION:  ',PRESENT_POSITION,
               IN SECONDS ')
    WRITELN;
    WRITE  ('  REQUESTED POSITION : ( ENTER "0" TO STOP) ');
    READLN( DESTINATION );

    IF DESTINATION > 0
    THEN BEGIN

      GO_TO_POSITION( DESTINATION - LEAD, PRESENT_POSITION );

      PLAY_TO_POSITION( DESTINATION, TAIL, PRESENT_POSITION );
    END;

  UNTIL DESTINATION = 0;

END.
```

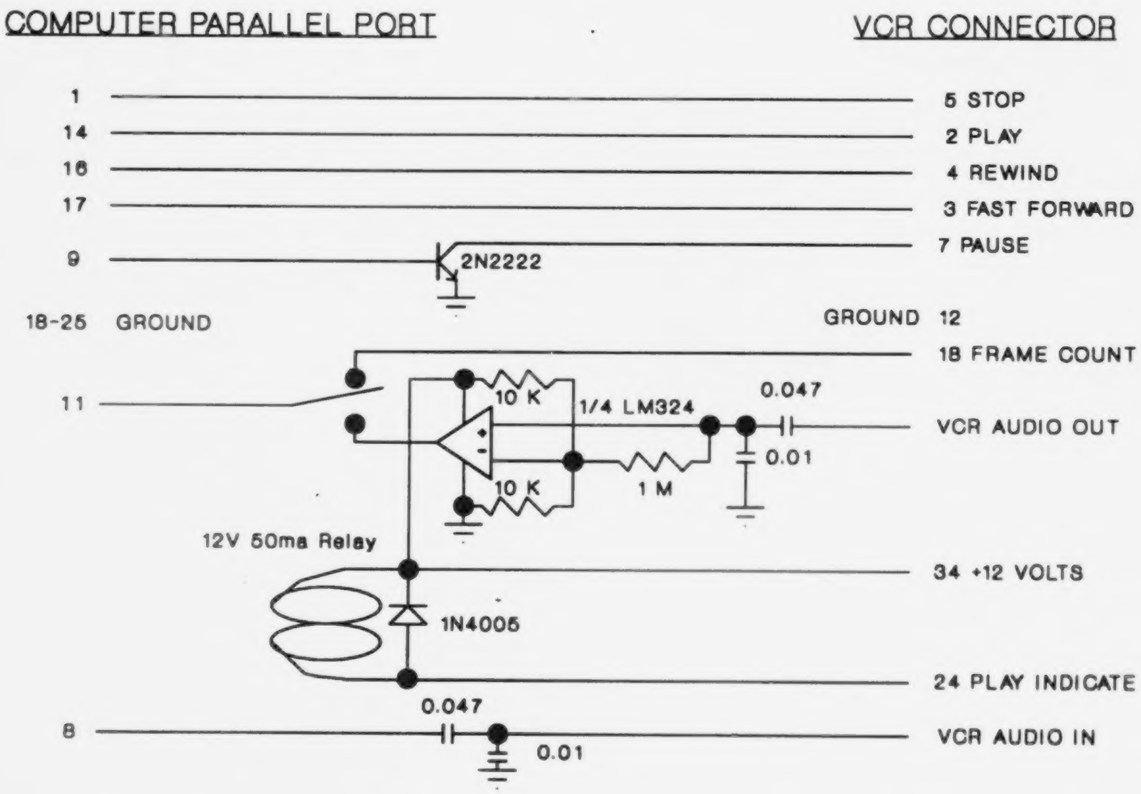
COMPUTER PARALLEL PORT
VCR CONNECTOR
1
14
16
17
9
18-25 GROUND
11
8
5 STOP
2 PLAY
4 REWIND
3 FAST FORWARD
7 PAUSE
2N2222
GROUND 12
18 FRAME COUNT
10 K
1/4 LM324
0.047
VCR AUDIO OUT
0.01
10 K
1 M
12V 50ma Relay
34 +12 VOLTS
1N4005
24 PLAY INDICATE
0.047
VCR AUDIO IN
0.01

Figure 2 Circuit diagram of the computer-video interface.

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# COMPUTER-BASED SIMULATION FOR SALES TRAINING

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ABSTRACT. In Spring 1989, Nationwide Insurance implemented its second interactive video course for use at the Nationwide Training Center. Consisting of five disc sides, the course is designed to provide novice agents with initial training on Nationwide's selling model, plus simulated experiences in the acquisition and practice of selling skills. Agents can select consultation sessions with an agency manager, open client portfolios as part of an exercise format, and work with a client couple in a selling simulation. The latter situation uses Performax Simulation System Trainer (SST) technology, in which an agent's interaction with a client is recorded with a VCR, available for replay as a continuous sequence. The course was developed primarily with in-house resources.

## COURSE STRUCTURE

The course title is "The Winning Edge: Five Steps to Success" and consists of five discs. The first four discs incorporate the content of the Nationwide selling model, divided among various selling steps, and include menu options to consult with an agency manager on the basics of a given step; to prepare for an appointment via identification-type exercises on finer points of the process; and to practice a particular step with a client couple. The practice sessions consist of client video sequences with embedded decision points, and it is here that the Performax SST unit and software enable the practice session to be highly interactive. After a client makes a statement or voices a concern, the image freezes, and the camera activates. The agent responds, then touches the screen (or a small hand-held remote) to turn the camera off. This cues the next client video segment. The sequence continues in this manner for each step in the selling process. By the end of the fourth disc, the interaction with the client couple reaches a natural conclusion, with either the agent closing a sale or the clients leaving dissatisfied.

The fifth disc, known as the "Challenge" session, enables the agent to integrate all five steps into a single appointment. There are no agency manager consultations, no preparation exercises, but a rather simulated appointment from start to finish with a single client couple. Use of the Performax technology makes the simulation highly interactive, and yet presented a number of challenges from a design perspective. The multiple and extensive branching patterns for a dialogue that could last forty minutes opened up a universe of possibilities. Video segments and decision points had to be tightly scripted to place boundaries on the simulation without constraining the interaction. In this way, a base storyline was developed from which deviations were anticipated. A certain degree of latitude was built into the design allowing an agent to get off track, to detect his/her errors, and to redirect the dialogue. If an agent misses the signals given by the client(s), and persists with an inappropriate strategy, then the branching concludes the appointment with feedback regarding the error(s).

The hardware and software for this course is an integrated unit consisting of a Pioneer D-V6010 disc player (or SONY LDP 1500), a Panasonic 6200 VCR, a Visage monitor, an IBM AT (or IBM PS2 Model 30), a Panasonic CD110 color camera, and an SST control unit developed and marketed by Performax, Inc. During any given simulation, the SST unit assists the VCR in "splicing" together the disc images with the videotaped segments. The simulation (whether practice or challenge) can be replayed from the VCR as a continuous appointment.

## SALES TRAINING ENVIRONMENT

Novice agents attend a two-week school at Nationwide's centralized training center, in which they are introduced to the selling model, reinforced in their product knowledge, and required to participate in live role plays and the IVD course. The "Winning Edge" course is interwoven with the school's curriculum, and is scheduled for individual or small group use on a daily basis using nine IVD units. The combination of live role plays with IVD creates an intense but effective training experience for the novice who is expected to begin sales production in earnest upon completion of the school. While the live role plays provide the essential human dynamic, the IVD course puts the selling process under a microscope, and permits an agent to practice, commit errors, and analyze the consequences of his or her actions.

## IMPLEMENTATION

A thorough, but basic, introduction to the hardware and its use is given at the outset of the school, and supervisors/instructors are on hand while the course is in use. Course content is reinforced during classroom sessions that involve the selling model. Instructors are also assigned to groups of agents as advisors who can provide feedback on progress through the course.

## EVALUATION

Data on IVD course usage has been and continues to be gathered from the agents via scaled items on weekly evaluation forms, informal discussions, interviews, and written comments. Reactions have been varied, and range from "I don't like or agree with the simulation's decision points" to "I think it provides an excellent means of practicing the selling steps." A tape of each agent's interaction with the client couple on disc five is given to the respective field manager for further assessment. Feedback from these managers to date indicates in many instances that the tapes reveal strengths and weaknesses previously unnoticed.

## DISCUSSION

At this writing, the course has been in use three months. Its use in each school has prompted fine-tuning in the curriculum, which in turn has yielded a slightly different set of agent reactions. Thus, it is not yet possible to draw definite conclusions from our findings. It is clear that live role plays are preferred to IVD (although preference does not preclude positive learning). This is not surprising in that sales people by personality tend to be concrete thinkers (Samuelsson, 1989), people-oriented, and very concerned with realism. The realism factor was addressed in all phases of the IVD course development, but a simulated appointment with set decision points appeared to be too constraining to some. Other contributing factors to the reception of learning via IVD have been equipment problems and discomfort with the technology. At times, the frustrations created by these factors overshadowed the intended benefits.

We will continue to monitor the effectiveness of IVD, combined with field management support, among novice agents as they complete their initial training and enter the field sales force. A study conducted jointly by IBM and Performax, Inc., yielded results that "...showed significant improvement in terms of sales call structure consistency and sales call skill effectiveness" (Alliger, Serbell, and Vada, 1989, p. 1). While this study holds promise, our data thus far does not permit us to make such conclusions.

## ACKNOWLEDGMENT

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# RAPID PROTOTYPING

## Solving the "Mystery" of IVD

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## ABSTRACT

Most "first-time" interactive videodisc clients have a limited idea of what the development process involves and a fuzzy vision of the end product. Clients unfamiliar with interactive videodisc technology must see ideas come to life to get an accurate grasp of the possibilities and limitations of IVD. Rapid prototyping is becoming a popular concept in the development of training and instructional materials, but the problems involved in using it with IVD are more complex than for other types of media. This paper presents steps for managing the cost-effective development of a rapid prototype videodisc as part of a larger IVD project.

Most clients shopping for a training program are at least somewhat familiar with Interactive Videodisc (IVD). But as yet many have not actually used it, nor participated in the development of an IVD training program. Increasing numbers of clients want to give IVD a try, but most "first-timers" have a limited idea of what the development process involves and a fuzzy vision of the end product. When inexperienced clients explain what they want from IVD projects, they may be guessing. When development proceeds on that basis, the developer steps into an expensive trap.

A conscientious developer will work closely with an inexperienced client to help that customer understand the problems of designing an effective IVD program. But even when extensive storyboarding is used to try to visualize the process and the product, the complexity of IVD and the variety of media involved may still leave the client with a sketchy notion of the end result of his project. If the end result is substantially different from the client's vision, the developer will face an unhappy client, costly revisions, or both. In these circumstances the developer may spend 80 percent of his time on what should comprise 20 percent of the project -- namely, revisions. That is inefficient, not to mention unprofitable.

Clients unfamiliar with IVD technology must see ideas come to life to get an accurate grasp of the possibilities and limitations of IVD. Storyboarding on paper is not enough: Rapid Prototyping goes beyond storyboarding to give life to clients' ideas and accurately demonstrate the possibilities (and limitations) of IVD.

Rapid Prototyping is the full development of a small prototype "module" very early in an IVD project, in order to give the client an accurate vision of what the finished product will look like and how it will work. Our purpose in utilizing Rapid Prototyping is to whittle down the potentially huge expenditure of time on revisions by providing the client an accurate picture, in miniature, of the entire IVD program. If the prototype IVD can reflect the project as a whole, the developer will spend less time on revisions.

Rapid Prototyping requires a project that is modular in nature. Given this condition, the project in which Rapid Prototyping will be used begins like any other IVD project -- with a needs assessment and the establishment of learning objectives. The general design of the project is brought to the client for sign-off. At this point, a critical decision must be made: which module will be selected for Rapid Prototyping?

The prototype module should be easily produced so that it can be ready in about a month. The prototype must be inclusive enough to demonstrate all the important aspects of the full training program, but also must be delivered quickly since a Rapid Prototype that is shown to the client late in the project is a wasted effort.

When an appropriate module has been selected, a script and storyboards are developed, and field video is shot and edited. Either a Direct-Read-And-Write (DRAW) videodisc or an eight-inch replicate videodisc is manufactured. The computer program is integrated with the videodisc.

If the full project has already been sold and designed, some development might proceed on other modules while the prototype is produced -- scriptwriting, perhaps. However, if the client's expectations are not well defined or the project is particularly complex, it may be wise to delay further development until the prototype is completed and approved.

In some cases, we have developed a prototype disc in advance of selling the full project. If the client decides to proceed with the entire IVD, the prototype becomes part of that package.

Once complete, the Rapid Prototype is presented to the client for review. At this point, the client has the opportunity to determine if the design, content and "look" of the prototype really reflect what he wants in the full project. Among the standards the customer will scrutinize in a Rapid Prototype are:

- o Content presentation (instructional strategies)
- o Color of the background & text
- o Screen design
- o Use of function keys
- o Branching design
- o Degree of user control
- o Degree of interactivity
- o Type of feedback
- o Record-keeping capability

Any of these can be changed now at a small fraction of the cost of revising them later, after the full project is finished. With the prototype in hand, the client has an accurate vision of the IVD program as a whole -- and a powerful tool to get skeptical colleagues and management enthused about the project. Just as important, the client's expectations have been made explicit to the developer. With IVD training, and its inherently large budgets, unmet client expectations can be very expensive.

It has been our experience that IVD projects proceed far more smoothly and efficiently with Rapid Prototyping. The client's uncertainty about the development process and the nature of the end product is largely eliminated. The developer can proceed, confident that the client approved content, scripts, storyboards and video with an accurate idea of how the IVD program will look when complete. And, of course, that huge chunk of expensive time at the end of the project is reduced as revisions are minimized.

Rapid Prototyping also contributes to better relationships between developer and client through the course of the IVD projects. The client becomes more knowledgeable early in the project as a result of the prototyping process. That knowledge also helps the client make more efficient use of his time during development of the full project. Now familiar with the technical and design context, his critical contribution in the areas of subject matter and content will be more effective.

The only additional expense of Rapid Prototyping is the cost of pressing the videodisc. Pressing an eight-inch replicate disc or a DRAW disc usually amounts to less than $1,000. The prototype is a "real" module -- it will become part of the full, finished IVD program -- so the cost of its development adds little to total project expense. As we've explained, this relatively small investment in Rapid Prototyping can yield a significant return in the form of savings on revisions.

The benefits of Rapid Prototyping to our company and our clients are unquestioned in our minds. We also believe Rapid Prototyping is improving the climate for IVD training by taking much of the "mystery" out of the development of IVD programs. Clients are more comfortable with a technology that's new to them if they understand its workings and have a precise notion of how they're spending their money. Rapid Prototyping provides that understanding, and much more, at a most reasonable cost.

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# FIELD TESTING THE "VIDEODISC PROJECTOR" CONCEPT

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## ABSTRACT

Despite the unquestionable potential of Level III interactive video, few teachers have incorporated it into their curricula. The author believes that teachers will be more likely to utilize videodiscs as lecture illustration tools than as sophisticated Level III tutorial systems. The Graphic Arts Education Videodisc Project is an attempt to test the viability of the "videodisc projector" concept in classrooms around the country.

## INTRODUCTION

Level III interactive video provides an information delivery system that has unquestionable potential. Successful applications to date include business, industry, and military training, public information systems, and point-of-purchase displays.

Despite these successful applications, interactive video has not, as yet, made significant inroads in public education. The arcane and relatively expensive hardware, as well as the general reluctance of educators to embrace any new instructional technology help to explain why interactive video has not taken public education by storm. Perhaps even more to the point, the development of quality Level III interactive video remains an expensive proposition. The resources typically afforded the public education sector are normally insufficient to support either the development costs or the end purchase price of Level III courseware.

Two factors contribute to the high cost of Level III interactive video courseware. The first is program design. Designing good quality computer-based instruction is very time consuming-- and instructional design costs money. Most educators are not well versed in courseware design, and those who are will charge dearly for their expertise. Moreover, it simply is not possible to short-change the design process and still end up with good quality courseware.

Similarly, the production of quality video, another essential for Level III interactive video, also requires ample time and expertise, which translate into expense. Low-budget video produced by educators on VHS equipment does not lend itself to quality instructional material.

Despite these impediments to the general acceptance of Level III interactive video in education, videodiscs may find a home in education as a part of "videodisc projector" systems. The "videodisc projector" concept utilizes the videodisc in much the same manner as one might use a slide or overhead projector. The videodisc becomes a visual data base to be called upon for illustrating lectures. These "generic" videodiscs, as they have come to be known, may contain countless slides and graphics, as well as carefully selected video segments.

There are a number of reasons why the "videodisc projector" approach may be more appropriate in America's classrooms than Level III courseware. First of all, most teachers are already comfortable with this concept. Many educators not only use overhead and slide projectors, but depend upon them as primary communication tools. For them, the videodisc projector is a small step, not the quantum leap that Level III courseware requires.

Secondly, generic videodiscs are less costly to produce than the video required for Level III courseware. Slides are often readily available, and video segments need not be designed for interactivity. There are also inherent advantages of videodiscs over slides or videotape alternatives. Most significant are the convenience of mass storage and the randomly accessible nature of the data.

The economies of videodisc mastering/duplication provide yet another argument for this approach. The cost of making 200 duplicates of a typical slide show of 80 slides is about $6400. For the same cost, a master and 200 copies of a videodisc may be produced that contain about 2500 slides.

## THE GRAPHIC ARTS EDUCATION VIDEODISC AND GAEVS

The Graphic Arts Education Videodisc contains more than 3,000 still frames and about twenty minutes of full-motion video relating to graphic arts materials, equipment, and processes. It was designed and intended to be used by graphic arts educators in support of their lectures.

The problem, of course, with storing thousands of still frames on a videodisc, is finding those slides on the videodisc when you need them. To solve this problem, the author developed a Macintosh HyperCard program known as the "Graphic Arts Education Videodisc Stack (GAEVS)."

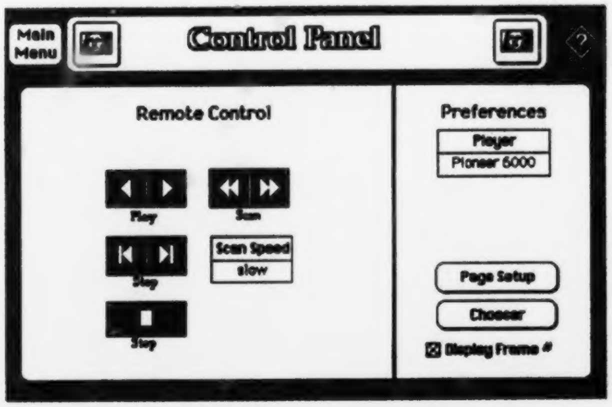
The hardware required includes a Macintosh with two floppy disk drives (or preferably a hard drive) and a videodisc player with an RS-232 port (e.g. Pioneer LD-V4200 or LD-V6010A). HyperCard, version 1.2 and a cable to connect the Macintosh to the videodisc player are also necessary to complete the system.

The logical place to begin with the GAEVS program is with the "Control Panel Card" (Figure 1). Here the user selects the particular videodisc player in use (to load the appropriate driver) and whether or not frame numbers should appear on the videodisc monitor. Remote control buttons on the card provide the basic control features: step, play, and fast forward or backward, as well as scan forward and backward at a variety of speeds.

The GAEVS software has two major components: one for cataloging and searching the still frames on the videodisc, and another one for handling full-motion video segments. The still frame cataloging feature is handled by the "Slide Records" stack. Each still frame on the videodisc has a corresponding "Slide Record Card" (Figure 2). When the videodisc player is online, the still frame appears on the color monitor, while its Slide Record Card displays on the Macintosh monitor (this option may be toggled off and on). Therefore, when you move through the Slide Record Cards with the arrow buttons, you actually are stepping through the still frames on the videodisc.

The Slide Record Cards contains fields for the chapter number, frame number, and description of each still frame. Each of these fields may be searched. When you click on the word "Description," for example, you are asked to type in a string, and GAEVS

Figure 1: Control Panel Card

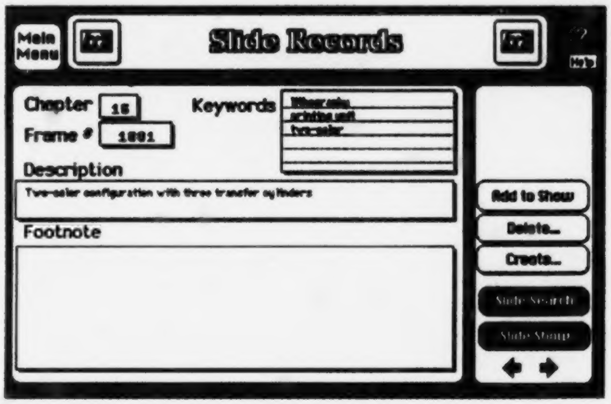


Player: Pioneer 6000

Scan Speed: slow

☒ Display Frame #

Figure 2: Slide Record Card



Chapter 15

Frame # 1801

Keywords: [illegible] / [illegible] / two-color

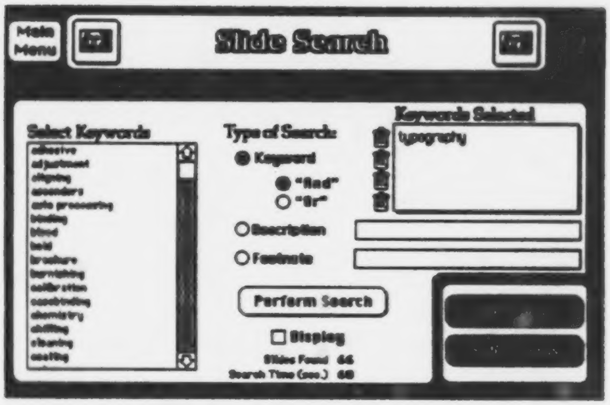
Description: Two-color configuration with three transfer cylinders

Footnote

immediately searches for the next occurrence of the string in the descrption field. The "Footnote" field is a space in which the user may type relevant information. They might put their lecture notes, for example, in this field. Or, it could be used for test questions (for a test students would take individually at the Macintosh). Perhaps most importantly, the Slide Record Cards also contain up to five keywords.

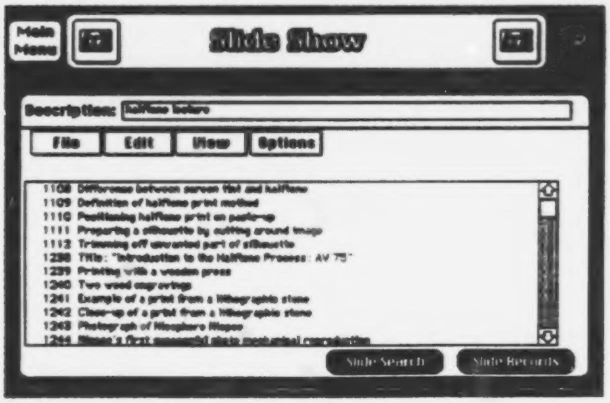
A complete list of keywords is located in a scrolling field on the "Slide Search Card" (Figure 3). The user may select one or more of these, and then perform either an "and" or "or" type search. GAEVS reports the number of still frames located, and the elapsed search time in seconds. The frame number and description of the still frames located by the search are stored on the "Slide Show Card" (Figure 4). Here the "slide show" may be edited with "cut" and "paste" features.

Figure 3: Slide Search Card


Main Menu
Slide Search
Select Keywords
adhesive
adjustment
aligning
ascenders
auto processing
binding
bold
brochure
burnishing
calibration
casebinding
chemistry
cleaning
coating
Type of Search:
● Keyword
● "And"
○ "Or"
○ Description
○ Footnote
Keywords Selected
Perform Search
☐ Display
Slides Found
Search Time (sec.)

Keywords Selected: typography

Figure 4: Slide Show Card

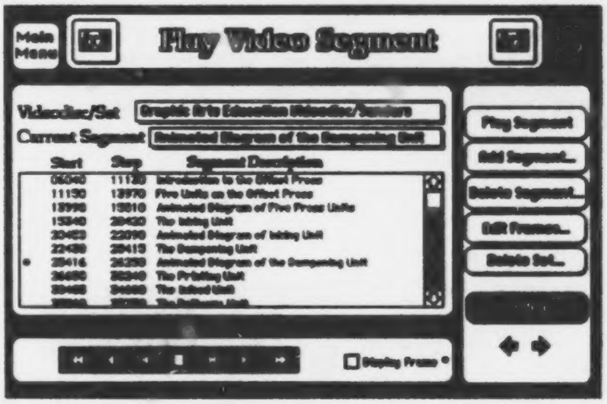

Main Menu
Slide Show
Description:
File
Edit
View
Options
Slide Search
Slide Records

1108 Difference between screen tint and halftone
1109 Definition of halftone print method
1110 Positioning halftone print on paste-up
1111 Preparing a silhouette by cutting around image
1112 Trimming off unwanted part of silhouette
1238 Title: "Introduction to the Halftone Process: AV 75"
1239 Printing with a wooden press
1240 Two wood engravings
1241 Example of a print from a lithographic stone
1242 Close-up of a print from a lithographic stone
1243 Photograph of Nicephore Niepce

When the slide show has been finalized, it may be saved to disk and/or printed. Just before the lecture, the teacher or trainer would reload the slide show, and display the slides as needed with a click of the mouse (as you would with a remote control on a slide projector). Alternatively, the slides may be displayed automatically at a predetermined time delay, or even continuously, as you might see at an exhibit booth at a trade show.

The "Play Video" portion of the program enables the user to create and play any number of video segments that may be on the videodisc. GAEVS is shipped with ten video segments, but the users can edit these, or create their own. When the "Add Segment" button is clicked (Figure 5), the program requests a start frame number, end frame number, and name for the segment. Then, clicking on the description that appears in the segment description immediately locates that segment, and waits there. The "Play Segment" button does just that. Similarly, selected segments may be edited or deleted.

Figure 5: Play Video Segment Card


Main Menu
Play Video Segment
Videodisc/Set
Current Segment
Start
Stop
Segment Description
Play Segment
Add Segment...
Delete Segment...
Edit Frames...
Delete Set...
☐ Display Frame #

Videodisc/Set: Graphic Arts Education Videodisc/Sanders
Current Segment: Animated Diagram of the Dampening Unit

Standard HyperCard navigational buttons appear throughout the stacks in the GAEVS program, as well as specific navigational buttons (shown in inverse) that go to other stacks in the GAEVS program. A "Main Menu" button at the top left of each card allows the user to "regroup" at any time. Online help, which is activiated by clicking on the Help icon that appears at the top right corner of each card. After that, any button or feature selected on the screen displays help information.

A number of useful utilities are bundled with the GAEVS software. The

"Install GAEVS" utility simply installs a GAEVS button on the HyperCard Home Card. More significantly, the "Modify Records" utility allows the user to create or edit "Slide Record Cards." Using this utility, for example, the user could add keywords to the current slide records to provide even more thorough search capability. Doing so would then require the use of the "Update Keywords" utility, which rebuilds the keyword list on the Slide Search Card by visiting the keyword field on each Slide Record Card. The user may also load and/or delete slide shows that have been created from the utility stack.

## GAEVS DOCUMENTATION

The documentation that accompanies the GAEVS program provides a comprehensive set of instructions detailing the use of the system. It also includes a hard-copy directory of each of the slides on the videodisc. This directory may be useful in getting an idea of what sort of slides (and how many) are on the videodisc. It serves as an off-line reference to the videodisc.

## FIELD TEST SITES

GAEVS is currently being field-tested in about 40 graphic arts programs throughout the country. The purpose of this field test is to provide formative data that would allow for improvement of the software via the revision process. In addition, the field test will serve to test the viability of the "videodisc projector" concept discussed earlier.

## THE VIDEODISC SHOWMAKER

It became evident during the development of the GAEVS software that it would be a relatively simple matter to produce a generic version of the software. In March, 1989, a beta version of "The Videodisc Showmaker (VSM)" was released. This software is virtually identical to GAEVS, with all references to the "Graphic Arts Education Videodisc" removed. Thus, anyone may use it to catalog and display slides and video segments on commercially available videodiscs (or for videodiscs they develop themselves).

## SUMMARY

There are no guarantees with new instructional technologies. If history provides any insight, the educational sector will continue to take a conservative approach to interactive video delivery systems. The author believes that widespread use of videodiscs in America's classrooms is more likely to occur in the "videodisc projector" mode than via sophisticated Level III tutorial courseware. The Graphic Arts Education Videodisc is an attempt to test the viability of the "videodisc projector" concept in graphic arts classrooms throughout the country.

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# A NEW INTERACTION: MORAL EDUCATION AND INTERACTIVE VIDEODISC

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## ABSTRACT

This paper presents a vision of moral education unrealized in traditional ethics courses. It assumes that the aim of ethics, the good life, involves a harmonization of beneficence, justice and dignity. In accord with this assumption, moral problems are often conceived as cases in which these three desiderata do not coincide. Interactive Video, partially as exemplified in "A Right to Die? The Case of Dax Cowart," an IVD from CDEC at Carnegie-Mellon University, has the potential so to teach ethical problems that (1) the statement of the ethical problem incorporates the lines of human interaction through which real problems develop, (2) students, more than merely learning contrary lines of moral reasoning for responding to ethical problems, learn to integrate realistic ideas about human motivation and about personal interaction into their ethical deliberations. The provision of such education in ethics courses holds the promise of increasing the level of responsibility it is reasonable to attribute as well as the level people can reasonably fulfill.

In Spring, 1989, I used the new Annenburg Series "Ethics in America" to teach Introduction to Ethics. The course is focused on (1) ten hour-long videotapes, supplemented by three hour-long audiotapes, (2) a Source Reader of short selections from Plato and Thucydides to John Rawls and Martin Luther King, Jr., and (3) a Study Guide, which recapitulates the tapes and amplifies the cultural norms underlying the values around which the individual videotapes are organized.

This course has two important advantages over many ethics courses. First is its continual focus on real or realistic problem scenarios. Introduction to Ethics can be taught as ethical theory in a manner sufficiently abstract that students do not sense the basis in life out of which the study of ethics grows; "Ethics in America" points to familiar situations as the experiential root of the study of ethics.

Second are the intelligent, well-educated persons who speak clearly and with the authority of experience in response to the problems. These audio- and videotapes certainly stress the seriousness of the study of ethics and the importance of intelligent reflection on the norms of one's society.

Despite these two advantages over non-media based courses, "Ethics in America" has significant weaknesses, weaknesses shared with many other introductory ethics courses. For students in "Ethics in America," like other introductory ethics students, see ethical reasoning as largely unhelpful and rather irrelevant to the existential circumstances in which persons confront ethical dilemmas.

## Problems of Traditional Ethics Instruction

The premise of "Ethics in America" is that ethics is the study of the conflict of the three fundamental values of human life: beneficence (since we are animals capable of being benefitted or harmed), justice (since we are social creatures) and freedom or dignity (since we have the capacity self-consciously to deliberate and choose our futures). Reasonably, the course assumes that no ethical problems arise so long as the action which promotes beneficence also does justice and respects freedom. The problems of ethics arise when beneficence, justice and freedom do not coincide.

Unhappily, again this semester, my students and I are experiencing the frustrations typical of ethics students and their professors: students find it very difficult to see how studying ethics makes them better off in confronting real-life moral dilemmas. After all, the dominant theme of the videotapes they see is that many prominent people, including a few professors of philosophy, can find almost no basis for agreeing about any ethical question. Thus, "Ethics in America" leaves professors with one of the major problems of moral education: for many students, merely learning patterns of justificatory reasoning doesn't show them how they are better off in confronting real life moral dilemmas.

Another problem, sensed by some students and professors, is that the study of ethics doesn't make people moral. Indeed it doesn't even increase the disposition to moral behavior of the average student of ethics. From the study of ethics one can learn several prominent patterns of reasoning in ethics. But, for many people, learning those reasoning patterns seems a hollow activity if it does nothing better than show how to provide rationales in support of opposite conclusions.

A related problem is that, while philosophers have agreed that a complete ethical theory must include a moral psychology, most courses in ethics either ignore moral psychology or posit, without discussion, various motivations people are assumed to have. Traditionally, there has been little basis for theoretical agreement about what motivations people do or, indeed, could have. And for this reason discussions of moral psychology have tended to be in the form of posits, abstractly stated as assumptions underlying lines of ethical reasoning. "Hobbes says man is egoistic" or "Rousseau presents society as the corruptor of human motivations." Accordingly, when moral education is abstracted from real motivations, ethical theory appears conjectural: tantalizing but finally irrelevant.

The final problem out of which my vision grows comes from the work of the French philosopher, Jacques Derrida, who argues that responsibility involves respondability. This means that part of what makes it reasonable to hold a person responsible for a situation is that that person has the capacity to respond, in word or deed, so as to contribute to the ameliorization of the situation. Human beings often experience regrets. "If only I had sensed then what I realize now." "I knew he was hurting, but I didn't know what to do." "She hurt me with her comment, so that I gave up trying to help even though I knew she needed it." All these motivations bespeak deficiencies in respondability. A feature of most moral dilemmas, no matter how grave, is that there are moments when they could have been ameliorated. It is utopian to expect education in ethics to yield only those happy circumstances in which beneficence, justice and freedom coincide, but persons can cultivate the skills through which to spot the moments at which interventions can be beneficial. Accordingly, a goal of moral education should be to increase the capacity of persons so to respond to moral problems as to contribute to their ameliorization.

## The Case of Dax Cowart and the Revision of Moral Education

In summary, then, four problems of traditional courses in ethics are that (1) ethical problems are so presented in ethics classes that the lines of interaction through which real problems develop are deleted from the problem statement, (2) students do not go beyond learning contrary lines of moral reasoning, (3) students never learn to integrate realistic ideas about human motivation into their ethical deliberations, and (4) ethics courses do not aim to improve students' respondability to moral problems. It is the thesis of this paper that IVD is a pedagogy well suited to help students learn the lines of interaction, see what is involved in choosing between contrary lines of reasoning, integrate ideas about human motivation into their ethical deliberations and respond more helpfully to moral problems.

To elicit the power of IVD for responding to the shortcomings of traditional ethics courses, I choose to tell you about the famous case of Dax Cowart, a story which began in 1970 and became the subject of a conventional videotape by 1973. Dax Cowart and his father were in the real estate business. One day in Texas, when they were looking over some land they were trying to sell, their car stalled out. Dax's father, having made some adjustments under the hood, asked Dax to try starting the car. When Dax did, the landscape exploded, killing his father immediately and burning well over 60% of Dax's body. Leakage from an uncapped gas well had set off the explosion and the biggest law suit in the history of Texas.

Dax was rushed to the hospital, where recently evolved burn therapies were undertaken. Because Dax was not conscious at the outset, these therapies were initially undertaken on the presumption that an unconscious patient in acute need desires to live. Dax's mother supported this presumption. When Dax became conscious, however, he found himself experiencing excruciating pain. Not only were his burns painful, but so also was his treatment. He expressed a desire not to be treated. He refused to consent to further treatment. At the same time, however, Dax was suffering delusions. He believed, groundlessly, that the hospital staff was conspiring to experiment on him. He laked a coherent sense of his whereabouts and condition. Given his mother's consent, the hospital continued therapy in the light of Dax's manifest irrationality.

In time, however, Dax overcame his delusions. He came to understand his situation clearly. He continued to experience immense pain. He experienced great frustration that his treatment continued, for over nine months, without his consent. He understood that without treatment the sores on his body would become infected, leading to his painful demise. And, in refusing treatment, he realized that to avoid that death he would require somebody's aid in helping him to kill himself after he was released from the hospital.

Since he still refused consent and began to argue that his civil rights were being violated, Dax was psychiatrically evaluated. The eventual finding was that Dax was rational and should, therefore, be allowed to make his own decision. Thereupon Dax chose further treatment.

## IVD and the Revision of Moral Education

Dramatic as this story is, the case of Dax Cowart is morally much more complex than conventional videotape can show. Did the possibility that Dax's mother might bring suit against the hospital if treatment were terminated overly influence the hospital in continuing to treat Dax long after his delusions ended? Were the doctors who offered Dax prognoses of treatments which were never realized too optimistic because of their desire to treat Dax? Does the fact that, after Dax was clearly rational and was allowed to choose, Dax chose treatment justify the hospital's decision to ignore his earlier requests for termination of treatment? And what of the hardships of Dax's subsequent life? Do they support the views of the lawyer Dax has since become that he should have been allowed to die?

None of these questions is explored in the original videotape Please Let Me Die. And each of them takes one down a distinct track from separate juncture points. Here IVD technology suggests itself as superior to a conventional videotape followed by class discussion for three reasons. First, seeing the whole videotape creates a global impact on students which makes them tend to ignore several of these questions. Second, it is much more poignant for individual students each to involve themselves in moving down the pathways than it is for the instructor to lead a class discussion. For in discussion only a smaller number of students participates and the instructor cannot respond to the emotional reactions of each of the students. Third, it is widely accepted (although disputed) that the ethical point of view is an abstracted understanding based on an understanding of the perspectives of the various parties involved in an ethical problem. Accordingly, students of ethics need systematically to explore the perspectives of each of the involved parties on their way to an abstracted ethical understanding.

Another strength of IVD instruction in ethics comes out by contrast to "Ethics in America," for even the apparently realistic cases around which "Ethics in America" is organized are presented unrealistically. An interlocutor asks us to imagine a case of certain description. For example, an economically poorer, scholarship student at an exclusive prep school, not having the money for a special course to prepare for college entrance exams, uses answers to the exams obtained by another student to get good scores on the exam.

While this case, as outlined, has surely occurred, the ethics student responding to the case is in a much different situation from the fellow student friend in whom the poor student confides his temptation to use the exam answers. The opportunities of friendship are not open to the ethics student. Nor will the ethics professor likely countenance a mention of such opportunities as responsive. For the opportunities of friendship are highly interactive. They require using the trust between the friends to elicit motivations, desires and fears. They require self-examination concerning what one makes of one's self as one remains loyal or as one withdraws from one's friend. The language of traditional instruction in ethics does not include the vocabulary for articulating these issues, and the "Ethics in America" videotape at best adds the observation of mock interaction in which the observer does not participate. Skills people develop only with much difficulty and experience would become more accessible if junctures were created in interactive videodiscs where students would learn both a vocabulary for articulating these issues and for understanding how different interactions at those junctures tend to lead to different outcomes.

One of the important features of the Carnegie-Mellon IVD, "A Right to Die? The Case of Dax Cowart," is its focus on the prominent obstacles Dax's burns have continued to pose not only in his effort to become a lawyer but in his personal relationships. However much his substantial handicaps may have contributed to the break-up of his first marriage, the IVD contains a picture of his relationship to his current wife, including the struggles and accommodations surrounding his disabilities. An IVD allows students to pursue alternative responses to Dax's disabilities to see how they exacerbate or ameliorate his struggles.

While students in traditional ethics courses are likely to learn contrary lines of reasoning which may be applied to an example, learning contrary lines of reasoning does not by itself provide students with any substantial clues about how to act (or even how to reason) when contrary lines of reasoning are applicable.

Indeed, the format of "Ethics in America" reinforces this problem because it allows articulate persons to express contrary views from contrary perspectives without offering students even a glimpse of how the theoretical rough spots of the perspectives translate into practical problems of implementation and interaction. In contrast, an interactive format requires the student to choose particular courses of action and to take responsibility for its outcomes. For example, when Dax was experiencing delusions, it was reasonable for the hospital to conclude that, because of his irrationality, he should not be making the decision about his treatment. But should the hospital have acquiesced in his mother's desire for his treatment? Should the hospital have assumed that his mother spoke for his own best interest, rather than predominantly out of her own grief at the loss of her husband and the prospect of the death of her only child? How might the hospital have pursued whether Dax should be treated without relying on either Dax or his mother?

One of the weaknesses of video instruction is the quick pace at which material is presented. The original Dax videotape, Please Let Me Die, exposed the viewer to the first nine months of Dax's treatment, up to the time of his psychiatric evaluation. With so many decisions and their consequences presented, the viewer is encouraged to take in the video as the presentation of accomplished fact. The possibilities and intricacies of interaction between Dax and hospital personnel slide out of focus, for the student typically lacks both the power of pausing the tape to reflect and regain emotional equilibrium and the ability to pursue the possibilities of different interactions.

In contrast, IVD ethics instruction can require students to integrate realistic ideas about human motivation into their ethical deliberations. The power of this gain is reflected in the recent work of the economist, Robert Frank. In his book, **Passions within Reason**, Frank begins from the important observation that, although biologists, psychologists and economists rely heavily on the postulates that material rewards and self-interest are the cornerstones of human motivation.

> And yet the plain fact is that many people do not fit the me-first caricature. They give anonymously to public television stations and private charities. They donate bone marrow to strangers with leukemia. They endure great trouble and expense to see justice done, even when it will not undo the original injury... Seen through the lens of modern self-interest theory, such behavior is the human equivalent of planets traveling in square orbits. (Frank, 1988) One of the great advantages of working with real cases is that one minimizes the risk of imposing theoretical presuppositions about human motivation.

Indeed, the thesis of **Passions within Reason** is that the development of emotions creates evolutionary advantages for organisms over other rational organisms which lack the emotional dispositions. Clearly, if this thesis is true, even with respect to some emotions and over some range of environments, the implications for moral psychology are profound. It is therefore instructive to consider Frank's argument for the evolutionary power of the development of emotional capacities: Frank asks us to consider the many situations in which the conscious pursuit of self-interest is incompatible with its attainment. He illustrates his point as follows:

> Jones has $200 leather briefcase that Smith covets. If Smith steals it, Jones must decide whether to press charges. If Jones, does, he will have to go to court.

> He will get his briefcase back and Smith will spend 60 days in jail, but the day in court will cost Jones $300 in lost earnings. Since this is more that the briefcase is worth, it would clearly not be in his material interest to press charges...
> But now suppose that Jones is not a pure rationalist; that if Smith steals his briefcase he will become outraged, and think nothing of losing a day's earnings, or even a week's, in order to see justice done. If Smith knows Jones will be driven by emotion, not reason, he will let the briefcase be. If people expect us to respond irrationally to the theft of our property, we will seldom need to, because it will not be in their interest to steal it. Being predisposed to respond irrationally serves much better here than being guided only by material self-interest. (Frank, 1988)

Frank's argument in Passions within Reason carries the implication, from an evolutionary viewpoint, that human beings will have as broad a range of emotional dispositions as has proved advantageous to the survival and reproduction of individuals. Moreover, since human beings are social animals, the environments in which they are pressed to succeed are largely social environments. Success in social environments centrally involves the ability of responding organisms to decipher the emotions expressed to them and to respond in ways beneficial to themselves and their progeny. Consequently, groups of individuals with the ability to perceive any fraud another individual might try to perpetrate will exert a coercive hold on the potentially fraudulent individual. For the perceptivity of the others will tend to force the potentially fraudulent individual toward cooperation.

The power of evolutionary theory in conjunction with studies of alliance formation in chimpanzees (Symons, 1979) leads me to conclude both that, as social animals, human beings should be expected to be richly emotional, and that judgments about right and wrong will have a basis in the evolved capacities of human beings to discern the dispositions of their fellows. Ethics courses, with the help of IVD, could teach ethics students to discern dispositions.

Yet it is important not to underplay the complexity of human responses, once someone has discerned others' dispositions. For the construct we call personality includes a large battery of overlapping skills and dispositions. Many basics are common, through socialization, to most or all of us. But equally important, much that defines the uniqueness of an individual falls within individual's differing abilities to elicit and to provide information, to sympathize and to gain sympathy, to elicit trust and prove one's self trustworthy, and to articulate visions and ensure cooperation. Neither human abilities nor the modes of human action in these areas are standard. Suppose I advise a friend that, although I could never do it, the right thing for my friend would be to do what only that friend can do. Part of what I mean is that my friend's personality enables my friend in ways I appreciate, though I cannot emulate.

Here, then, is a vision for IVD. We become the persons we are. We develop our personalities. We acquire skills and dispositions we have lacked. The goal of ethics is not simply to spot circumstances in which the pursuit of beneficence, justice and dignity will tend to conflict. Certainly the goal of ethics is not the articulation of contrary lines of reasoning about those conflict situations. Ethics is a serious subject matter because humans are social animals for whom coordination is desirable, although not instinctive. Accordingly, ethics will be a much enriched subject matter when its students can learn from it the better how to harmonize beneficence, justice and dignity. But learning that involves learning how to develop the skills and dispositions which come to constitute one's personality.

## Conclusion

To understand what action is appropriate in situations where values conflict, one needs to see the possible developments of the situation from the perspective of each of the parties involved. One needs to see what issues of beneficence, justice and freedom arise from each of the perspectives. IVD facilitates such understanding by allowing students to take the perspective of each of the parties, one at a time, and follow it through the various junctures of the situation. The best actions are ones which coordinate the basic values of beneficence, justice and freedom for each of the involved parties. Accordingly, cultivating the ethical point of view requires envisioning what actions one might best take, indeed, what courses of interaction one might best undertake, to facilitate and harmonize those basic values.

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# The Interactive Multimedia Research and Development Laboratory in Higher Education

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## ABSTRACT

The interest in hypertext, hypermedia or multimedia application for teaching and learning has dramatically increased during the past 18 months. This interest has been fanned by the introduction of new computer hardware and software for developing and presenting multimedia based learning applications. This paper describes the components of a multimedia research and development laboratory created at Lehigh University.

## INTRODUCTION

Designing interactive multimedia learning environments involves essentially three activities: creating a multimedia knowledge domain, selecting the appropriate tools for organizing, storing, accessing and presenting multimedia knowledge domains and strategies for linking the learner with the content domain for cognitive processing. Creating knowledge structures involves the representation of subject matter content and the interrelationships among this information. Once the knowledge base has been established, it can then be converted to a format(s) compatible with the storage medium. In most cases, a knowledge domain will require the electronic transformation and linking of related information. Most educational institutions are not prepared to nor do they have the necessary hardware and software to produce interactive multimedia knowledge databases.

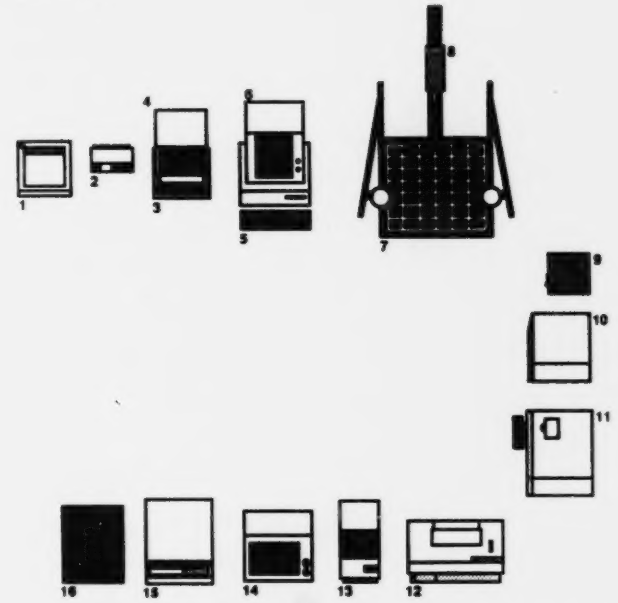
## FUNCTIONS AND CAPABILITIES OF THE MULTIMEDIA R&D LABORATORY

The Interactive Multimedia facility serves as a laboratory for conducting research and development activities related to the use of advanced digital visualization techniques and technologies applied to teaching and learning. The laboratory facility includes advanced microcomputer workstations equipped with image capture hardware and sophisticated image processing software. Images are captured in real-time from a variety of sources: video cameras, 35mm slides, videodiscs, videotapes, or other computers. Once digitized by the computer, these images can be manipulated, enhanced, and output to disk, film, print, videotape, digital or optical disc, and other media. The laboratory also includes sophisticated 3D image rendering and animation capabilities. Advanced digital video effects are used to create animation by rendering images out to videotape frame by frame. The result is a full color, smooth 3D animation sequence that can be incorporated into any linear production or interactive multimedia learning activity.

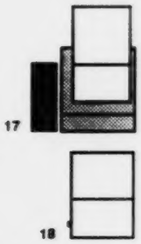
## COMPONENTS OF THE MULTIMEDIA R & D LABORATORY

This paper presents a model interactive multimedia laboratory that can be used by personnel in higher education to produce effective interactive multimedia knowledge databases.

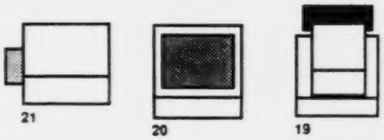
The following table (1.0) depicts the requirements for a digital multimedia production facility.



1. KURTA Graphics Tablet
2. Panasonic Video Switcher
3. PIONEER Laservision Player
4. Sony Trinitron Monitor
5. IBM Personal Computer AT
6. Monitor
7. KAISER Image Stand
8. JVC Video Camera
9. TAMRON FOTOVIX Film Video Processor
10. Panasonic Optical Disc Recorder TQ-2026F
11. Dunn Instrument Film Recorder
12. XEROX Color Printer
13. Macintosh SE
14. AMDEK Monitor
15. Panasonic Optical Disc Player TQ-2027F
16. PIONEER LVD-6000 Video Disc Player



17. IBM Personal Computer AT
18. Sony Trinitron Video Monitor
19. Mac II
20. Sharp 300 DPI Color Scanner
21. Tektronix 4693D Option 44 Color Printer



## NAMES AND DESCRIPTIONS OF LABORATORY EQUIPMENT:

KURTA Graphics Tablet - The KURTA tablet is interfaced to the PC providing access to the TIPS paint software. Its range of features allows you to draw, select menus and enhance the dimensions of the TIPS paint software.

Panasonic Video Switcher - This active switcher is a compact accessory for use in color or black-and-white video production systems. The six composite video inputs can be switched to a single video output.

PIONEER Laservision Player - This Laservision Player LD-838D can play 12-inch diameter and 8-inch diameter LaserVision Discs. In the lab the player is used as an image input device. It is connected to the desktop switcher.

Sony Trinitron Monitor.

IBM Personal Computer AT and Monitor - The IBM/PC AT contains the Targa 16 Truevision Imaging Video board, the TIPS paint software and the TOPAS 3-D modeling software.

KAISER Image Stand and JVC Video Camera - The image stand with video camera is used as an image input device. The distance of the camera from the image can be adjusted using a crank on the image stand. The camera has a macro lens for close-ups.

TAMRON FOTOVIX Film Video Processor - This is an image input device. The processor lets the user project both positive and negative film on the monitor. The film can be manipulated with the processor using a zoom option, a color enhancer, a brightness controller, and a focuser.

Panasonic Optical Disc Recorder TQ-2026F - This device is used to record images, sound and motion video that are used in the development of education and training courseware and presentations.

DUNN Instrument Film Recorder - The DUNN Recorder records graphic images caputred with the Targa 16 board as 35mm slides, negatives, or film transparencies.

XEROX Color Printer - This is a color inkjet printer. It produces a color document captured by the Targa 16 board on the PC/AT.

Macintosh SE - The Macintosh SE microcomputer along with the HyperCard software is used with the Panasonic TQ-2026F/TQ-2027F Recorder and Player for developing prototype interactive videodisc educational and training materials.

AMDEK Monitor.

Panasonic Optical Disc Player TQ-2027F - The TQ-2027F is a play only videodisc player. It will only play the 8" videodisc recorded with the Panasonic TQ-2026F Player/Recorder device.

PIONEER LVD-6000 Video Disc Player - The LVD-6000 Video Disc Player plays the standard 12" videodisc. It has resident memory and can therefore be programmed to interact with the microcomputer for remotely controlling both the videodisc player and the computer via a remote control unit.

IBM Personal Computer AT and Monitor - The IBM/PC AT contains the Targa 16 Truevision Imaging Video board, the TIPS paint software, Inscriber video titling software, and Splash.

Sony Trinitron Video Monitor.

Mac II - The Mac II contains the software Laser Paint Color II and Pixel Paint. Both packages are used to enhance the scanned images. Laser Paint Color II also contains the driver for the scanner.

Sharp 300 DPI Color Scanner - This is a 300 DPI scanner which recognizes the smallest detail. It reads red, green and blue components in one scan, and is capable of reproducing more than 260,000 colors of different contrasts and hues.

TEKTRONIX 4693D OPTION 44 Color Printer - This is a fast, high-quality color printer with multi-user and multi-tasking capabilities, plus state-of-the-art image processing. The 4693D prints more than 16 million colors and 256 shades of gray at 300 dots per inch.

Ensoniq SQ-80 Synthesizer - This synthesizer contains 120 stored sounds. It will store (internally) 20 songs and 60 sequences. There is 8-track editing for each sequence. It can be used as a stand alone keyboard for composition and performance.

Ensoniq EPS Performance Sampler - The Sampler contains 56 disks of sampled sounds.

Ensoniq Mirage Sampler - The Sampler contains 11 disks of sampled sounds.

BOSE Speaker/Amplifier

Macintosh Plus - The Music Construction Set, OpCode Systems Sequencer, and Professional Composer and Performer are located on the Macintosh Plus.

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# Channeling Creativity to be the Driving Force of Interactive Videodisc

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## ABSTRACT

Standard interactive videodisc (IVD) guidelines can sometimes stifle creativity. The design process for this labor and delivery simulation is described, including questions used to direct creative clinical applications. While the authors contend that there is no one right way to produce IVD programs, they point to creativity as the true power of the videodisc.

## INTRODUCTION

The ultimate challenge to today's software developers is to maximize their creativity by effective use of available technology. This challenge is no different for those creating interactive videodisc applications, but is perhaps more complex. Besides designing applications that will make the full use of the computer technology, these developers are faced with added visual, auditory and touch screen possibilities that complicate the design process.

A propensity of resources exist for the novice IVD developer who wishes to learn about the standard process of this type of development (Floyd & Floyd, 1982; Iuppa, 1984; Parsloe, 1985; Schwier, 1988). It is often left to the reader to recognize that steps of this process can be done concurrently and will vary according to the application. At the same time, the reader is left with the design dilemma of focusing creativity so that it can be presented with this technology (no easy task), and one that comes with experience. But, at the same time that we are teaching the standard design approach, are we not also choking that same creativity that we are seeking to enhance? By altering the design process for our labor and delivery simulation, we were able to better channel that creativity so that the educational program was enhanced by being presented via IVD.

## CHOICE OF IVD

First and foremost are the questions used to ascertain whether this technology is appropriate for the selected content. All the creativity in the world is not worth the time, if this media is not the method of choice! IVD is an expensive proposition, and should be valued as such. Sales, Gordon, & Anderson (1986) reported initial screening questions which are listed as the first five questions in Table 1. Based on our experience since that time, the remaining questions were added.

Table 1
Initial Screening Questions for IVD Selection

1) Would an interactive videodisc program increase the effectiveness of the instruction over traditional modes of delivery?
2) Is the detail needed in the video beyond that possible through

computer graphics?
3) Does the lesson require random access to video segments or multiple "start and stop" locations?
4) Is the proposed content of the video portion stable (i.e. likely to remain accurate over time)?
5) Will the video content require more than 30 minutes of running time? If so, additional costs must be considered.
6) Are the instructional benefits of IVD worth the financial cost and personnel time?
7) Are personnel likely to gain credit toward promotion and tenure if they devote time to development of IVD? Would they be better advised to publish via a different media?
8) What hardware requirements will be necessary to deliver the IVD program to its intended audience? Can existing delivery systems within the educational unit be used, or must additional purchases be made?

As a result of using these questions, IVD was chosen as the preferred method of presentation for our program, primarily due to the realistic simulation needs. In an effort to expand our imagination to meet the possibilities of this technology, we began initial development in an unorthodox fashion.

## THE DESIGN PROCESS

Three entire days were spent in brainstorming about ways that this technology could enhance clinical teaching of the topic. The content expert had not developed using this media before, but was secure in her years of teaching experience, and knowledgeable about the content. Her co-authors had IVD development background, and began to ask questions that helped to mold initial ideas into a format useful for the touch screen. The types of questions generated were as follows:

1) What visual things can you identify that you would like for all nursing students coming through an obstetrics rotation to see?
2) If you could capture the best visual images in your years of teaching what would the end product consist of? Or, what things have you taken your students to see on "walking grand rounds" in the hospital?
3) What are the most difficult content areas to teach in your clinical setting? What makes that teaching so tough? How can visual, tactile, and auditory cues help this?
4) What clinical activities would you be interested in having students perform interactively.....or better phrased, what things are you never sure that your students know? What content do they require re-explanation of, and when you explain it again and again, how do you change your style of presentation?
5) What are clinical situations that you would consider life-threatening and intervene before a student could make an independent decision?
6) What are the sounds that are unique to this clinical teaching area?
7) How do students use touch in providing nursing care for the family?
8) What psychomotor skills are unique to this content that can be enhanced with visual presentation?
9) What are situations that require clinical decisions by students who need immediate feedback that is not always available in realistic clinical teaching settings?
10) What slide bank possibilities exist for teaching this content?

Applying these questions to our brainstorming task helped us to formulate initial creative ideas that formed the backbone of the program. Keep in mind that this was done BEFORE actual development of program objectives or flow charting in an effort to grasp the general "look and feel" possibilities without worrying about presentation details. (The very admission of this ordering is akin to cardinal sin for some developers, so if you are one of them we must apologize!). The reality of the initial development is best illustrated by the answers to the above formulated questions.

## THE RESULTS

Of primary concern to the content expert was the fact that students assigned to the labor and delivery experience could not be guaranteed that patients would be there. Furthermore, when having the clinical experience for a limited number of hours, students might only participate during selected aspects of care, and in fact never see an actual delivery. This fragmented educational process could be corrected by designing a realistic simulation which would assure every student a clinical experience beginning with admission and ending with the postpartum care.

Other visual enhancements were identified by the depiction of varying patient behaviors throughout the progression of labor; the filming of the delivery itself for the student to view and analyze; visual inspection of various placentas to determine if they were complete or incomplete upon delivery; and the presentation/descent of the fetus down the birth canal using models and graphics for student manipulation purposes. The ability to visualize the fetus internally was identified as a "trouble" spot in the curriculum, as students have traditionally had difficulty in visualizing the fetus after reflecting on the physical exam findings, including an extension of that visualization on a different plane to determine the presenting part they would expect to see appear vaginally.

The vaginal examination (to determine cervical dilatation) was noted to be particularly difficult to teach, probably due to the individual nature of the exam, knowing what to feel for, and converting this determination into an exact measurement. The developers actually spent several hours reviewing this exam on a model, before determining ways to use touch and graphics to simulate this experience.

Performing Leopold's Maneuvers was another "problem" skill to teach. These maneuvers, consisting of four parts, comprise an abdominal exam to determine fetal positioning. Again, the use of touch and graphics (by adding the outline of the fetus over the abdomen) were identified as possibilities. Other touch possibilities were to identify scrub order prior to delivery, to identify information on patient records which requires intervention or more assessment, and to chart patient information in graphics format.

Fetal heart sounds were determined to be important, as well as the evaluation of the resulting monitored strip. The sounds of family bonding, and the delivery itself, helped to portray the emotions of the moment and illustrate why each delivery is such a unique experience. An opportunity to see and hear the infant would mean a chance to do APGAR scoring which could then be compared to the score obtained by the clinical expert. In short, visual, auditory, and tactile possibilities were all explored at this point. No mention was given to possible technological restraints in an effort to not stifle imaginative ideas. The completed program actually included all the "brainstormed" areas, with only minimal compromise in format. Of course, these very words describing the possibilities are themselves inadequate. The full impact of the creative use of the IVD technology can only be obtained by viewing the completed program. Our purpose was to describe to you the process and questions used to aid in the transformation of that information.

## SUMMARY AND CONCLUSIONS

Software development is both an art and a science, just as is the practice of nursing. As with any art form, how specifically do you teach a student to mold the clay, to hold the brush, or blend the colors? How do you teach a developer wanting to work with IVD how to make the transition to producing for this media? One can cite principles of screen design, and research regarding length of program segments, but not how to transform the content into the technology. One can only push for those ideas, and urge developers to keep open imaginations, while pressing the technology to its limits. This creative challenge (and not the hardware, video or authoring environment) is truly the driving force of the videodisc. After all, the technology is only as good as the software that directs it.

The intangible nature of that word "creativity" makes it difficult to measure as well as to teach. DeBloois (1988) recently updated his report on the use and effectiveness of videodisc training. As before, outcomes were generally noted in terms of learning retention and attitude toward the technology rather than on appropriate choice of teaching methodology, or creative/unique applications that enhanced current teaching. Those outcomes addressed the "science" of the discipline. We are urging you, as IVD developers, to devote a substantial amount of effort to the "art" component as well. While our situation related to clinical teaching problems, the brainstorming process itself may be enough to start those creative juices flowing in more of a matrix approach for your next project.

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# Towards a cognitive theory of student cooperation in CAI

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## ABSTRACT

An advanced CAI program is used to do cognitive experiments comparing cooperative CAI with individual CAI. The program is based upon the instructional model of Berlin & White (1986) which prescribes a transfer of the student through a cognitive matrix representing the subject matter. Elements of this matrix are characterized by 2 factors, level of abstraction and level of movement (static, animation, and direct manipulation). Students are required to travel through the matrix towards higher levels of abstraction using adjacent elements in the matrix.

In an exploratory study freshman female Psychology students worked in pairs or individually. The pairs were composed in such a way that interactions between personality (extraversion / introversion) and intellectual ability (IQ) could be studied. The sessions are videotaped and the video-protocols are analyzed in the framework of a first order cognitive model which predicts superior performance of the pair composed out of an introvert, high IQ and an extravert, low IQ student.

The results of these studies will be used to adjust the cognitive model of cooperation. Such a model has implications for each cooperative learning activity, not only for CAI. Furthermore the results are going to be used to implement features in the courseware itself specifically geared at enhancing the cooperation of the students.

## INTRODUCTION

CAI is thought to be an effective way of teaching because the teaching actions are ideally based upon the specific individual cognitive state of the learner. Cooperative CAI is therefore a 'contradictio in terminis'. The cognitive map of two or more learners collaborating in the same CAI lesson might be quite different and a teaching strategy appropriate for one might be detrimental for the other. Studies on cooperative CAI do never show negative achievement scores when compared with the individual training (Johnson et al. 1985; Mevarech et al. 1987). Several explanations can be given for these findings. In the first place it appears that many CAI-lessons are not that adaptive to the individual cognitive status as they could be. For instance mastery learning based programs virtually are based upon an average student model.

Secondly, cooperation might have benificial effects upon the learning of both learners thus counterbalancing potential negative effects of less individually fitted teaching actions. (This paper does not deal with the more consisent findings of a beneficial effect of cooperation on social behaviour).

The beneficial effect could arise from two factors (Mevarech, 1988). The first one reflects the poor quality of many CAI-lessons today. Many machine-user interfaces in CAI-lessons are so bad that frequently misunderstandings in the communication occur. The frequency of these miscommunication is thought to decrease if more than one user is present.

The more interesting reason for a potential beneficial effect is that cooperative CAI induces peer-teaching which has been established outside the context of CAI as a superior teaching approach (Webb, 1982). It is of interest that in the field of 'Intelligent' Teaching Systems several research programs now try to develop an artificial learning companion rather than a artificial teacher in order to mimic the peer-teaching situation (Self, 1985).

### *Dynamics of Cooperation*

The inconsistency of the experimental data with regard to cooperative CAI might be explained by the fact that in the majority of studies no effort was undertaken to specify cognitive relevant pairing criteria.

It is clear that just putting two students in front of a terminal does not yield an optimal cooperation. Therefore some research has been done on optimal pairing. Most of this research studies the effect of a single factor in the pairing like 'Intelligence' or 'Gender' (Johnson et al, 1983; Dalton, 1988).

In the present exploratory study two factors are considered. This is done on the basis of a zero order model of the peer-teaching process. In this model we suppose that the optimal situation arises when the least capabel of the two partners is an extravert and exposes his/her misconceptions while the more introvert and more capable of the two takes mostly the role of a peer tutor.

## METHOD

### *Subjects*

As subjects 6 subjects (freshman psychology) participated in the experimental (cooperative) condition while 12 subjects were used in the control (individual CAI) condition. 3 pairs were formed from the 6 experimental Ss using intelligence and introversion measures. The pairs were composed as folows.

Average IQ/ Extravert with Average IQ / Extravert (pair 1)

Average IQ/ Introvert with Average IQ / Introvert (pair 2)

Low IQ / Extravert with High IQ / Introvert (pair 3)

Due to limited availability of student with identical pretreatment knowledge the pair High IQ/ Extravert with Low IQ / Introvert could'nt be formed.

### *Treatment*

All pairs followed a CAI-lesson on Statistics. The CAI-lesson has been developped after an extensive analysis of most common misconceptions in the target-group. The teaching strategy is consistently based upon the instructional model of Berlin & White (1988). This model prescribes a transfer of the student through a cognitive matrix representing a concept or nodein the subject matter. Elements of this matrix are characterized by 2 factors, level of abstraction and level of movement (static, animation, and direct manipulation). Students are required to travel through this matrix towards higher levels of abstraction using adjacent elements of the matrix. The concepts are represented in a tree-like network which is worked through from the more general towards the more specific concepts. Once a concept has been treated the student is allowed at any moment to visit the concept again. The lesson is implemented using the authoring environment *Course of Action* which proved to be a stimulating tool to create well structured lessons with a uniform user-interface which, we hope, does not suffer from inadequacies resulting in communication errors.

All experimental sessions are videotaped in such a way that interactions between the subjects and the CAI-lesson screen is visible.

### *Data analysis*

In contrast with traditional Aptitude Treatment Interaction research our analysis will focus on qualitative analysis without bypassing a quantitative analysis. Cognitive ATI research is expected to produce cognitive process models whereas traditional ATI-research mostly yielded behaviouristic input-output relations (Kamsteeg, 1989). For instance in exeriments exploring the effect of Gender-pairing (Dalton, 1988) a major recommendation follows from direct observations of the pairs. It was observed that competitive behaviour between males and females increases dramatically. And a major recommendation from that study was that this effect should be taken into account in the instructional design phase for cooper ative CAI. Because our ultimate goal is the development of specific CAI lessons which intensify the positive effects of the peer-teaching effect in cooperative CAI it is mandatory to get at a process model of cooperative CAI.

Quantitative analysis will be done using scores on a representative test taken one day after the treatment. However due to the limited number of experimental pairs these results can only be of limited value.

### *Hypothesis & explorations*

Our hypothesis pertains to the zero order model sketched above. We expect superior achievement of the pairs which are composed of HIGH IQ-introvert with LOW-IQ-extravert subjects. Qualitative explorations will use the interaction protocols. The non verbal interactions will be scored according to a scoring scheme developped by Leary (1957)

## RESULTS

### *Quantitative*

In table I the mean post-test scores in the CAI and the CCAI condition are given. A t-test between the two groups does not yield a significant difference (t=1.37; df=16). This is not surprising since we expect mostly positive effects from specific pairings.

| | CAI-ind. | Cooperative CAI |
|---|---|---|
| N | 12 | 6 |
| Mean posttest score | 14 | 12 |
| Standard Deviation | 2.13 | 5.15 |

Table 1: Scores after treatment

Therefore the post-test scores per pair in the CCAI condition is given in table 2

| | | IQ (z) | Extrav. (z) | Posttest |
|---|---|---|---|---|
| Pair 1 | Extravert/ Av. IQ | .55 | 1.78 | 16 |
| | Extravert/ Av. IQ | 1.00 | 0.88 | 15 |
| Pair2 | Introvert/ Av. IQ | 0.65 | -1.14 | 12 |
| | Introvert/ Av. IQ | 0.20 | -1.48 | 6 |
| Pair 3 | Introvert / High IQ | 1.41 | -0.85 | 15 |
| | Extravert / Low IQ | -1.47 | 0.49 | 8 |

Table 2: Scores for each member of each pair

The most pronounced effect appears to be that the pair consisting out of two introverts did obtain a combined score of 9 which is significantly less than the average score of the individual students. The score of the (very) Low IQ subject in pair 3 (8) is higher that of the average IQ student in pair 2. This suggests that the interaction in pair 3 certainly was inducing more learning in this weak student. Although this is what we expected from our simple model we did not anticipate that pair 1 would score the highest. In order to understand these figures a qualitative analyses of the protocols is required.

### *Qualitiative*

The qualitative analysis is in progress at the time of submission of this report. Data will be available at the time of the conference.

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# Computer Based Evaluation: A Comparison of Student Response Patterns

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## Abstract

The purpose of this study was to compare student responses to items on two types of a faculty evaluation instrument - the classic "paper and pencil" rating instrument, and a computer administered rating instrument. The reliability for each instrument was the same, and there were few significant differences between the student responses for each item based on type of administration. Students using computers as part of the course they were evaluating also took the same amount of time completing the computer administered evaluation instrument as did students who did not use computers as part of the class they were evaluating. Although the ratings of Lickert scale items were similar with both types of instruments, students using the computer administered instrument included more open-ended comments, and the comments tended to be more constructive or negative than those included on the paper and pencil instrument.

## Introduction

With the costs of computers decreasing, power of computers increasing, and people's familiarity with software increasing, computers are rapidly becoming a readily available and important tool in educational settings. The computer's increasing capacity for storing, processing, managing, and presenting information has been an encouraging factor in the development of a variety of educational computer applications. In the past ten years we have witnessed a significant increase in the development, evaluation, implementation, and utilization of software for computer-based instruction (CBI), computer-managed instruction (CMI), and computer-based testing (CBT). Future computer applications in education may also include computer-based course evaluation systems. A system of this type can provide a very consistent and efficient method of administering, interpreting, and monitoring evaluations. Information collected can maintain complete anonymity, and can be processed very quickly, providing rapid summaries and feedback. Longterm analysis of evaluations could be quite easy to document and maintain.

Student ratings of faculty, one component of a comprehensive evaluation system, have long been a common means of collecting information for both formative and summative insight into instructional effectiveness (Aleamoni, 1981). Student ratings of faculty can provide very important and valuable diagnostic information, and when employed effectively, the results can provide a great wealth of informative assessment and feedback with respect to instructional effectiveness. However, evaluations can easily be misadministered or misinterpreted, resulting in very biased information.

Many guidelines have been established to facilitate effective administration and collection of faculty evaluations (Marsh, 1984). By far the most popular method is that of paper and pencil survey instruments. While several people have developed and validated very useful instruments, it is generally agreed that any instrument should address three domains; 1) individual characteristics of effective instruction, 2) global ratings of course structure, and 3) open-ended comments (Marsh & Overall, 1980). Paper and pencil instruments have been utilized for some time, yet there are several inherent problems associated with this method of evaluation. The greatest problem is that students sometimes do not evaluate each item independently, but rather all items are given the same rating, thus providing a global rating rather that individual factor ratings.

## Purpose of the Study

The purpose of this study is to compare two methods of administration of faculty evaluations: the classic paper and pencil instrument and a computer administered instrument. It is hypothesized that since computer administered evaluations can be structured such that only one question is presented at a time, each question will be answered independently of another, with the responses on the computer administered evaluation reflecting more variability than responses on the paper and pencil instrument. This type of presentation mode can serve to facilitate independent rating of items, rather than a global assessment of all items. It is also hypothesized that computer administered evaluations provide a means of total anonymity, thus influencing the quantity and quantity of open ended responses to evaluation questions. An additional hypothesis was that the interaction with the computer would not hinder student input and responses, even if students were not familiar with computers as part of their classroom settings.

## Method

### *Subjects*

The subjects consisted of 256 upperclass undergraduate students (juniors and seniors). Of these students, one group (100 students) was enrolled in a class that did not use computers as part of the coursework. The second group (156 students) was enrolled in a class that used computers extensively as part of the coursework. Each group was asked to evaluate the course they were enrolled in.

### *Evaluation Instruments*

Two instruments were used for this study. Each of the instruments contained 15 items, focusing on Course Objectives and Content, Assignments and Grading, and Instructional Effectiveness of the Lecturer. Also included were areas for open-ended comments by the students. The first instrument was a standard paper and pencil Course Evaluation form, patterned after the evaluation form developed by the Center for Teaching Excellence at Texas A&M University. The second instrument was a computer administered evaluation with the same items presented in the same sequence as the paper and pencil form.

### *Dependent Measures*

Item Rating Each of the items was rated using a 5 point Lickert Scale, with 1 representing the highest rating, and 5 representing the lowest rating. Of the 15 total items, 3 items specifically addressed course objectives and content, 5 items specifically addressed assignments and grading, and 7 items specifically addressed the instructional effectiveness of the lecturer.

Response Latency For students taking the computer administered evaluation, response time per item was measured in seconds, beginning from the time they were prompted to rate the item until they typed their response.

Response Pattern The students responses were evaluated with respect to their pattern of responses; did each statement receive the same rating (pattern) or were the statements rated differently (no pattern)?

Open-Ended Comments There were 5 sections provided for any open-ended comments the students might wish to add. Comments were analyzed with respect to their content and length.

### *Procedures*

The course evaluations were completed at the end of the semester in the microcomputer lab. As each student entered the lab, they were randomly given one of the two versions of the course evaluation instrument. Each student responded to the evaluation independently. Students using the computer version of the evaluation were given instructions to follow the prompts on the screen, and enter their responses via the keyboard. At the end of the evaluation, their responses were automatically stored to a hard disk, and the program returned to the beginning screen. Students using the paper version of the evaluation were asked to return their evaluations to a large envelope, in which all the evaluations were randomly placed.

### *Design and Data Analysis*

The internal consistency reliability of each evaluation instrument was calculated using Cronbach's Alpha. Since two distinctly different courses were being evaluated, the mean ratings of the two groups were not compared for this study. Within each group, differences between the ratings from the computer version and ratings from the paper version were compared using an independent t-test, and the F max test for homogeneity of variance Item response time between students who used computers in class and those who did not use computers in class was also compared using an independent t test with the F' test for homogeneity of variance. The response patterns were analyzed using a two-way Chi Square procedure. Qualitative data in the form of open-ended comments was summarized using frequency tables.

### Results

The internal consistency reliability for each version of the evaluation instrument was very high, and not significantly different from each other. The paper version of the evaluation instrument had a reliability of .9429 while the reliability for the computer version of the evaluation instrument was .9358.

Student response patterns were categorized into two groups; if all items were rated the same it was considered a "pattern" of responses, and if there was any variation in item ratings, it was considered "no pattern" of responses. Of the 152 students using the computer evaluation instrument, 18 people rated every item on the instrument the same. Of the 104 students using the paper version, 7 students rated every item on the instrument the same. Table 1 shows that the 2X2 chi-square analysis of the item response patterns of both groups were not significantly different from each other.

Table 1. A 2 X 2 Contingency Table for Item Response Patterns

| | Computer Version | Paper Version |
|---|---|---|
| Pattern | 18 | 7 |
| No Pattern | 134 | 97 |
| | $x^2 = 1.83$ | |

The mean and standard deviation for each item on both versions the evaluation instrument was calculated for the group of students who used computers daily as part of their class. A t-test was then calculated to test for differences of the item means between the paper version and the computer version of the evaluation instruments. Of the 15 items, there was no significant differences between any of the item means( $p< .05$). Figure 1 presents the graph of these comparisons. An F' test was used to test the homogeneity of the item variances between versions, and again, there were no significant differences between item variances.

The same data analysis was applied to the item responses given by the group of students who did not use computers as part of the course they were evaluating. Of the 15 items, again, there were no items that had significantly different means ($p<.05$) Figure 2 presents the graph of these comparisons. An F' test was used to test the homogeneity of the item variances between versions, and only item 13 was found to have a significant difference between variances ($F'=1.91$, $p<.05$).

Item response times were compared between all students using the computer evaluation instrument. Overall, there was only one item (item 5, $t$ -3.30, $p<.05$)) that showed any significant difference between response times for students who had or had not been using computers during their course. Figure 3 presents the graph of these comparisons. However, the accompanying F' test did show that for item response times more than half of the items (items 1,2,3,4,5,9,13,14,15) did not support the assumption of homogeneity of variances.

The portion of the evaluation instrument reserved for students to include any open-ended comments was analyzed using a frequency table. The student's comments tended to fall into two distinct lengths "Phrases" consisted of remarks between 1 and 10 words. Next there was a large shift to much longer "narrative" comments.

The focus of the comments also fell naturally into three types, either very negative (eg. "get rid of the book", "I was bored", "the assignments were busywork"), constructive comments (eg. "more lab time would have helped", "more computers would lesson the waiting time"), and praise (eg. "This was the best class", "the TA was very patient").

Overall, students in both classes who used the computer version of the evaluation used the opportunity to include more open-ended comments than students using the paper version of the evaluation. Of the comments made, there was a slight shift towards more "constructive" or "negative" comments, although contained in shorter phrases. Table 2 presents the summary of the quantity and quality of open-ended comments included in the student ratings instruments.

### Discussion

The design of paper version of the evaluation instrument allowed students to see all the items included on the instrument at once, and provided opportunity to preview and review items while completing the evaluation. The computer version of the instrument presented each item singularly on the screen, and students were not able to review prior items that had been rated, nor were they able to see what items would be presented next. It was thought that this method of presentation would encourage independent ratings of each item. The hypothesis that the item ratings on the computer administered evaluation instrument would show greater variability than the same evaluation instrument given via paper format was not supported. The two methods of administration yielded very similar results, with no significant differences between individual item ratings. Even though both versions of the instrument did yield very similar item ratings, looking at the individual items, the differences between item ratings reflects that items were assessed independently, regardless of the type of administration of the instrument.

These same results were seen for students evaluating a class that included extensive computer work, as well for students that were evaluating a class that included no computer work. Thus students who were not familiar with the use of computers in a classroom setting did not rate items on the computer version of the evaluation instrument any differently than did students familiar with computers in the class environment.

Another concern was that students who were not familiar with computers in the classroom might have difficulty interacting with a computer program, having concerns as to how to input responses, or how to continue with the program. The concerns could be expressed as verbal questions during the evaluation session (which were not evident) or could seen as longer times to input responses for items. The item response time for both groups of students (familiar and not familiar with computers in the classroom) showed no significant differences, indicating that even though students may not have used computers at any other time in the class, they did not take any inordinate lengths of time to input their responses.

Prior use of paper evaluation instruments has also shown that many evaluations are completed with all items rated the same. This pattern indicates a less than thorough assessment of each item independently, but rather a type of global assessment of the course. It was hypothesized that the presentation of one item at a time (using the computer version) would promote individual assessment of items, and that there would be fewer evaluations with all items rated the same. This assumption did not hold true. Approximately 12% of the students using the computer version rated all the items the same, while only 7% of the students using the paper version rated all the items the same. While this is not statistically significant, certainly this trend is opposite of what was desired.

Prior use of paper evaluation instruments has shown that the least used portion on a paper evaluation instrument is the section(s) for open-ended comments. It is quite easy for students to pass over these sections and only rate given items. However, on the computer evaluation instrument, screens for open-ended comments were presented, and the student had to type a response or press a specified key to continue with the program. It was found that both groups of students who used the computer evaluation instrument included more short phrase open-ended comments, and a greater percentage of these comments were directed towards constructive criticism or negative comments.

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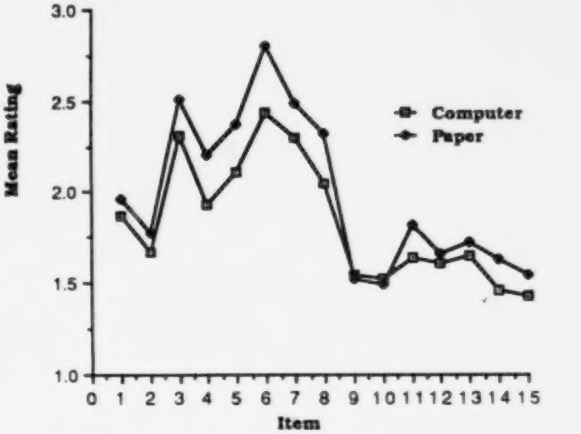

Figure 1. Comparison of item means for students using computers during the course.

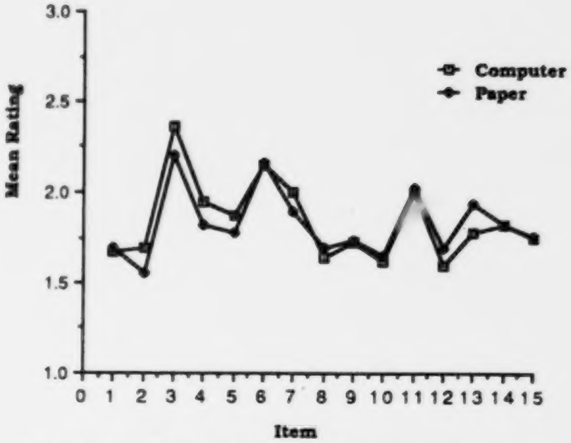

Figure 2. Comparison of item means for students not using computers during the course.

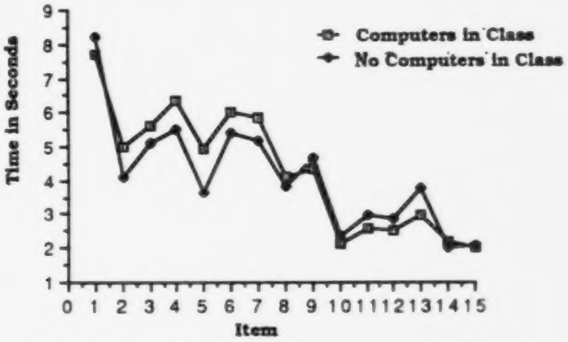

Figure 3. Item response times for students using the computer evaluation instrument.

Table 2. Percentage of Open-Ended Comments on All Versions of Evaluations

| | None | Phrases | | | Narrative | | |
|---|---|---|---|---|---|---|---|
| | | Praise | Constructive | Neg | Praise | Constructive | Neg |
| **Computers In Class** | | | | | | | |
| Paper Version (n=59) | 7% | 22% | 27% | 0% | 9% | 30% | 5% |
| Computer Version (n=97) | 0% | 23% | 35% | 4% | 8% | 27% | 4% |
| **No Computers In Class** | | | | | | | |
| Paper Version (n=45) | 16% | 25% | 27% | 2% | 3% | 25% | 2% |
| Computer Version (n=55) | 5% | 25% | 36% | 8% | 4% | 18% | 4% |

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# AI FOR COMPUTER-BASED INSTRUCTION

## A CASE STUDY

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## ABSTRACT

Five years of development have resulted in AI-based instructional foreign language adventure games in Latin and French. We found that experienced CAI developers can make the transition to AI projects and produce a usable program. We learned also that such a program requires several features not found in commercial games, and that a semantics-based parser works well with the ill-formed input students provide.

It was in 1984 that we proposed adapting the commercial computer adventure format to foreign language instruction in our specialties, French and Latin. The University of Delaware funded the project at first, and for two years we had major assistance from the U.S. Department of Education. This allowed us to employ a project team which has ranged from five to seven in number. Artificial Intelligence techniques were essential to accomplish our goals, so we began in Lisp on a VAX. From there the program migrated to a Xerox 1108 Dandelion, next to an IBM AT and Arity Prolog, and then to its present host, a Sun 3 and Quintus Prolog.

Like the commercial variety, our adventure game creates a miniature world for the player to investigate, explore, and eventually master. The player takes the initiative by typing statements, such as "I go east" or "I open the trap door" or "I read the inscription" or "I attack the ghost." The program responds to each statement either by carrying it out (that is, modifying the imaginary world) or by telling the player his statement was inappropriate or ineffective. The door may be locked, the inscription too faint to read without a stronger light, or the ghost unimpressed by physical violence.

Unlike commercial computer adventures, ours aims at instruction. Figure 1 shows our list of priorities, with reading and all its subskills first, then simple production, then culture, and last, details of the plot. In a sense, the whole program is an elaborate device to trick the student into a lot of reading and a little production. For this reason it uses no graphics at all; the student must deal exclusively in language. We thus endorse the thesis that students acquire a foreign language best by using it as language--a communicative tool for solving problems and pursuing rational goals.

Figure 1

PRIORITIES

| TEACHER | STUDENT |
|---|---|
| Reading | Game Content (Plot) |
| Production | Culture |
| Cultural Elements | Production |
| Game Content (Plot) | Reading |

To support the language learner, our program needed features not present in commercial adventures:

1. **Spelling Correction.** If a student types, "Inspicio orbem lapedum," "I examine the circle of stones," with lapidum misspelled, the program should echo, "...orbem lapidum?"

2. **Morphological Correction.** If a student types, "Silex acutus sumo," "I pick up the sharp flint," with the flint in the

wrong grammatical case, the program should echo, "Silicem acutum...?"

3. **Parsing of the Player's Foreign-Language Input and Drawing Inferences from the Knowledge Base.** If the student types, "Restem gladio seco," "I cut the rope with the sword," the program should reply, "Restem secuisti. Nunc restes duos vides," "You have cut the rope. Now you see two pieces of rope."

4. **Avoidance of Maze-Solving.** Commercial adventure games are dominated by compass directions. An instructional game should allow a variety of ways to express where one wants to go. It should be possible to use not only compass directions, but handsides--"I run to the left", or even goals--"I walk into the field" or "I return to the peasant's cottage." Once a player has been to a place, he should be able to return to it at any time (assuming that there are no obstacles) just by typing, "I return to ____." To assure clarity, a map should be available which shows all the locations known to the player, and it should grow as his knowledge grows.

5. **Help in Understanding Any Text on the Screen.** The student should be able to move the mouse cursor to any word on the screen, click on it, and obtain lexical or morphological information. Thus, if he selected the word **inceperunt**, the program should offer the dictionary key ("incipio"), the English meaning ("begin"), a morphological analysis ("third plural perfect active indicative"), or a paradigm of the word in the perfect active indicative. The student should be able to do this with any word on the screen, including those he himself may have typed.

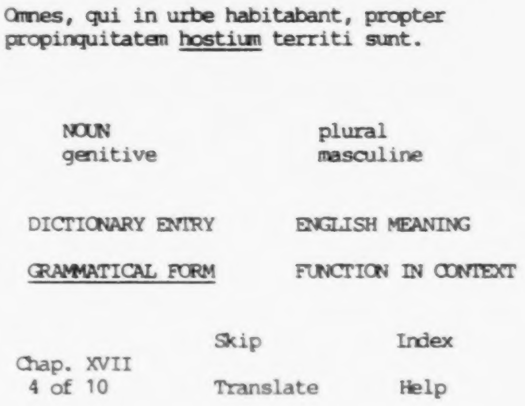
6. **Help with Game Strategies.** If uncertain what to do next, the student should be able to call up lists of verbs by semantic category and see model expressions for each verb.

7. **Provision for Teachers to Design Their Own Scenarios.** Some of the most creative and committed teachers find it distasteful to use software which they cannot modify to fit their individual needs. Adventure software would be much more useful if teachers could write their own scenarios and plug them into the game's parser and inferencing capabilities. Even better, they could include the class in a project to write a complete French or Latin game scenario, discussing each stage as it is implemented, and then running the completed game.

Notice, however, that the program is not an intelligent tutoring system. It builds no model of student understanding, nor does it coach the student in the usually understood sense. It simply provides a logical and consistent environment with which the student can interact, and then attempts to understand what the student types and offer reasonable responses.

Before we look at an exchange from the Latin adventure game, here for comparison (Fig. 2) is an example of traditional CAI in Latin. It is a translation exercise, but it separates translation into two phases: a data gathering phase and an integration phase. In the first, the student may select any word in the sentence and see its dictionary entry, English meaning, grammatical form, or function in context. In the figure, the student has chosen hostium and opted to see its grammatical form, which is displayed in the large box. After checking any doubtful items, the student selects "Translate" and types a translation which is marked for misspelled, missing or extra words, and for words out of order. Some synonyms are recognized. The sentences come directly from a database, and each is presented without larger context.

Figure 2



Omnes, qui in urbe habitabant, propter propinquitatem hostium territi sunt.

NOUN plural
genitive masculine

DICTIONARY ENTRY ENGLISH MEANING

GRAMMATICAL FORM FUNCTION IN CONTEXT

Skip Index
Chap. XVII
4 of 10 Translate Help

Now here is a sequence from the Latin version of the adventure game. Here the player is a survivor of the military defeat suffered by the Romans under Varus in the Teutoburg forest of Germany in AD 9 and must try to avoid capture while making his way back to friendly territory. Along the way, this student happened upon an eagle, the standard of one of the defeatedlegions, hung up in a grove. The following is, by the way, an unedited transcript from a third-semester Latin student, done Nov. 18, 1988:

| Lucus Silvae | Forest Grove |
|---|---|
| Ad silvae lucum semita te duxit. Ex parte omni arbores maximae ad caelum surgunt. Hic locus barbaris religionem quandam habet, ut omnis miles Romanus scit. Suspensa de arboris magnae ramis est aquila XVII legionis. | The path has brought you to a forest grove. On every side immense trees rise toward the sky. This place is a sacred one for the Germans, as every Roman soldier knows. Hanging from the branches of a great tree is the eagle of the seventeenth legion. |
| › Tollo aquiliam | › I take the eagle. |
| Volebasne scribere, "Tollo aquilam"?<br>[corrects his spelling] | |
| › Ita | › Right. |
| Aquila in reste haeret. | The eagle is attached to the rope. |
| (student checks haeret and verbs on acquiring) | |
| › Tollo arborem | › I take the tree. |
| Arbor non movetur. | The tree does not move. |
| › Tollo restem | › I take the rope. |
| Restis longe supra te est. | The rope is far above you. |
| (student checks supra and verbs on moving) | |
| › Ascendo arborem | |
| › I climb the tree. | |
| Nunc in arbore es. | Now you are in the tree. |
| › Tollo aquilam | › I take the eagle. |
| Aquila in reste haeret | The eagle is attached to the rope. |
| › Caedo restem | › I cut the rope. |
| Quo uti vis? | What do you want to use? |
| (student checks utor) | |
| › Caedo restem gladio | › I cut the rope with the sword. |

| | |
|---|---|
| Restem secuisti; aquila xvii legionis de arbore luci soluta est. | You have cut the rope; the eagle of the 17th legion has been freed from the tree of the grove. |
| (student checks secuisti, soluta, luci) | |
| › Tollo aquilam | › I take the eagle. |
| Aquila longe infra te est. | The eagle is far below you. |
| (student checks infra) | |
| › Descendo aborem | › I climb down the tree. |
| Volebasne..."Descendo ex arbore"?<br>[corrects spelling and usage] | |
| › Ita | › Right. |
| In solo nunc es. | Now you are on the ground. |
| › Tollo aquila | › I take the eagle. |
| Volebasne..."Tollo aquilam"?<br>[corrects the form of aquila] | |
| › Ita | › Right. |
| Aquilam tenes. | You have the eagle. |

Notice how pursuit of the goal dominates the student's activity. He misspells a form, but the program just echoes a correct version and lets him proceed. Finding the eagle is tied in place, he tries to take the tree (!), then the rope. When the latter turns out to be above him, he promptly climbs the tree and endeavors to cut the rope. The program nudges him to tell what instrument he plans to use, and the eagle falls free. Climbing down again puts him in position to claim the prize. Along the way, the student has three times had his usage corrected, has checked on two different semantic categories of Latin verbs, and has looked up seven words--some for form, some for meaning--all without the need to take his eyes off the screen. Throughout, the student's attention has been focused on getting that eagle. In the process, he carried out a continuing exchange with the computer.

Contrast this with the Latin CAI program mentioned above; although it too provides lexical and grammatical information on demand, it is overtly a translation exercise. The task at hand is simply to produce an English sentence that corresponds in certain ways with the Latin model. A meaningful context is conspicuously absent, and the meaning of the isolated sentence is only marginally relevant to what the student is doing.

Here is an episode from the French game. The student is both a good French student (so corrections are few) and a seasoned player (so he is easily able to deduce the appropriate actions).

| | |
|---|---|
| › je vais à la maison du berger | › I go to the shepherd's house [but the student is right in front of it, so the program corrects:] |

| | |
|---|---|
| --J'entre dans la maison du berger? | --I go into the shepherd's house? |
| › oui | › yes |
| L'intérieur de la maison du berger est simple mais propre. Un feu brûle dans la cheminée. Le berger vous accueille gravement. Il vous offre du vin et du fromage.<br>Il y a une table par terre.<br>Sur la table il y a un verre.<br>Dans le verre il y a du vin.<br>Sur la table il y a du fromage.<br>Il y a deux chaises par terre.<br>Vous avez très faim.<br>Vous avez très soif.<br>[ student looks up "feu," "accueille" ] | The inside of the shepherd's house is unelaborate but clean. A fire burns in the fireplace. The shepherd greets you soberly. He offers you wine and cheese.<br>There is a table on the floor.<br>On the table there is a glass.<br>In the glass there is some wine.<br>On the table there is some cheese.<br>There are two chairs on the floor.<br>You are very hungry.<br>You are very thirsty. |
| › je mange du fromage | › I eat some cheese |
| Vous avez le fromage.<br>Le fromage est bon. Vous n'avez plus faim.<br>Le berger vous offre aussi du vin rouge.<br>Vous avez très soif. | You have the cheese.<br>The cheese is good. You are no longer hungry.<br>The shepherd offers you some red wine as well.<br>You are very thirsty. |
| › je bois du vin | › I drink some wine |
| Vous avez le verre.<br>Le vin est bon. Vous n'avez plus soif.<br>Le verre est sur la table.<br>Le berger vous regarde et dit: "Tu as bu de mon vin et tu as mangé de mon fromage. Je suis vieux et le travail m'est difficile. Acceptes-tu de mener paître mon troupeau dans les collines?"<br>[ student looks up "paître," "mener," "troupeau" ] | You have the glass.<br>The wine is good. You are no longer thirsty.<br>The glass is on the table.<br>The shepherd looks at you and says: "You have drunk my wine and you have eaten my cheese. I am old and work is hard for me. Do you agree to lead my flock to graze in the hills?" |
| › oui | › yes |
| Le berger est très content. Il vous dit de sortir et d'ouvrir la barrière de l'enclos; les moutons vous suivront. Vous devez les mener dans la colline et revenir après la première neige. Le berger vous offre un sac pour le voyage.<br>[ student looks up "revenir" ] | The shepherd is very happy. He tells you to go out and open the gate of the pen; the sheep will follow you. You must lead them into the hills and come back after the first snow. The shepherd offers you a pack for the journey. |
| › je prends le sac | › I take the pack |
| Vous avez le sac. | You have the pack. |
| › j'ouvre le sac | › I open the pack |

| | |
|---|---|
| Le sac est ouvert. | The pack is open. |
| › je regarde le sac | › I look at the pack |
| Dans le sac il y a du fromage.<br>Dans le sac il y a un briquet.<br>Dans le sac il y a une bouteille.<br>Dans la bouteille il y a du vin.<br>[ student looks up "briquet" ] | In the pack there is some cheese.<br>In the pack there is a flint.<br>In the pack there is a bottle.<br>In the bottle there is some wine. |
| › je pars | › I leave |
| Vous êtes devant la maison du berger. | You are in front of the shepherd's house. |

---

Let us consider this session with the game both from the point of view of an adventure-game player and as a language-learning exercise.

Adventure-game aficionados will see two differences between this dialogue and that of the typical commercial game. First of all, the "plot" of this game is outrageously transparent; the player is constantly being given the baldest of hints about what to do next. A sort of shorthand is allowed for actions that are logically compound: you can drink the wine from the glass on the table without bothering to pick it up first or put it down afterward. The program fills in the details. All that, of course, is on purpose; we deliberately avoided the cleverness of the usual adventure-game plot, and some of the pickiness of conventional adventure-game logic, because we perceived in early trials that few students have the stomach to handle both a foreign language and a difficult puzzle at the same time. The choice may seem cowardly, but it is striking that this particular student, a veteran adventure-game player who would have found the game utterly uninteresting in English, pursued it for many hours in French.

Second--this is more subtle--in a commercial adventure game there would not be **two** chairs or **some** wine. Commercial games deal in unique entities and avoid mass nouns. Dealing with numbers of things greater than one (where each of the individuals is indistiguishable from the others) and indefinite quantities of liquids added a good deal of complexity to our world representation; but a dialog in French, for students of French, clearly needs to use language rich in variously-quantified nouns.

As a language-learning exercise, the dialogue is noteworthy for its extreme freedom. Although this player elected to do, in general, the obvious thing, there were many other ways to express the things he said (and many of them would be correctly interpreted by the program); and there were many other things that players might do. One student attacked the shepherd; another talked to him about the Duke (players of this game tend to be much preoccupied with the Duke). No player has yet stood on a chair or carried one out of the house, but both are legal actions. This program, in other words, does not have a list of the inputs, with variants, that are legal in each circumstance. Instead, it has a collection of grammar rules and rules for the assignment of meaning to words; it has an internal representation of the places and the objects in the game, and a series of rules about what happens when various sorts of objects are picked up, drunk, burned, cut, and so forth. Of course, it has a number of rules applying only in exceptional circumstances; these are the ones that most obviously propel the action forward in the session above. The shepherd will make his speech about drinking his wine and eating his cheese only if the player drinks his wine and eats his cheese. The benefits of a rule-based organization are, as we forsaw when we chose this method, a delightfully rich set of utterances and actions that can be understood by the game at any given point in the plot. The language the students use is motivated, not by any instructor-supplied linguistic cue, but by their own intentions, and those intentions arise from their understanding of the situation described to them. As it happens, that cognitive paradigm--understanding, intention, expression--is central to most orthodox modern theories of second-language acquisition.

So far we have attempted to give an idea of the history of our project and the nature of the product it has produced. The actual functioning of the program has been described in far greater detail elsewhere. A case study of the project, however, should include some discussion of the project's experiences as a guide to other CBE developers who see that Artificial Intelligence may offer comparable benefits for their applications, but who would like to know the pitfalls and costs before they begin.

It must be stressed that we were novices at the outset--novices as regards Artificial Intelligence, though we were experienced CBE developers. We spent the first year of the project educating ourselves. We took courses, read books, and built experimental programs. Four years later, it is remarkable how many things turned out to be easier than we thought.

First of all, we had the impression that Artificial Intelligence uses abstruse techniques and is conducted in an imposingly difficult hardware and software environment. This turned out to be by and large untrue. In the area that interested us--natural language processing--the cutting edge of research has moved far beyond the simple tasks that interested us; for those tasks, proven techniques have emerged, supported by standardized languages and documented in polished textbooks. There are AI languages and development environments on several machines--the IBM PC among them--which are stable, easy to learn, and powerful. Just how powerful may be shown by an incident that occurred in the summer of 1987. We had been developing the game on three tracks, which had produced a French input module, a Latin input module, and an execution module. The French and Latin modules analyze the student's language and produce a command for the execution module, which carries out the command and informs the user of the result. For a year, we had been feeding French or Latin in and getting commands out, or feeding commands in and getting French or Latin out, but we had never put French in and got French out, and we had scarcely more than a week to go before our first testers were to arrive on campus with every expectation of doing exactly that. We started the process of assembling the whole game with some trepidation. Each of the modules was, after all, a large Prolog program with a large database, which consumed very nearly all the available memory. But the process of putting them together was almost uneventful--in fact, anticlimactic. The system was quite prepared to handle the combined program's memory requirements, however great, merely by paging data out to disk and retrieving it on demand. The program ran very slowly because of all this disk activity--but it ran, immediately and, from the mechanical point of view, flawlessly.

A second pitfall we feared was machine dependence. We were the veterans of lengthy and expensive efforts to convert software from one machine to another. Are not AI systems so elaborate that programs are captive in the machine where they start out? Again, our fears were exaggerated. When the game moved from the Xerox Dandelion to the IBM-PC/AT, it was young enough to take only its conceptual core; rather than moving it, we rebuilt it, and it was ripe for rebuilding. When, on the other hand, we moved from the PC to the Sun workstation, we found a sister Prolog on the larger machine and needed only minor adjustments--less than a month's work--to have the same code running on the new machine. The issues that affect portability--screen resolution, I/O support--are the ones we know from our more mundane projects. There are no new surprises peculiar to AI projects.

We had always known that a project's pace was in large part determined by the undergraduate programmers. At Delaware, they are responsible for much of the day-to-day work. We feared that it would be difficult to hire students qualified to do natural-language processing and knowledge representation in Prolog. On the contrary, we have been blessed with a series of student programmers whose brilliance was no less remarkable than their reliability. Our project is interesting and it looks good on a resume; those merits, along with a vigorous and selective recruiting process, have served us well.

Artificial Intelligence not only met our instructional goals; it turned out to be learnable, doable, portable, and staffable. To our very great fortune, it turned out to be fundable as well. Are there then no drawbacks? What, you may ask, is the bad news?

Well, there is the small matter of the program's speed. In its present form, after several optimizations, it is in fact still too slow for comfortable use on a Sun 3-50 with four megabytes of memory; it is common for twenty seconds to go by after you press RETURN, before the program deigns to tell you, for instance, that the door is closed. On an eight-megabyte Sun times are quite reasonable--averaging three or four seconds. Our announced goal at the outset, however, was to have the program run on machines that high schools can afford. We are a long way from achieving acceptable response on even an upscale PC. It is not out of the question--if Zork can do it, so can we--but it will take cleverness and doggedness to achieve that goal. Artificial Intelligence programs by their very nature use large data structures and expensive processing methods. By these means, they demonstrate a gratifyingly rapid development process and impressive early results; but if a large AI program is to run quickly, it will require either a costly delivery machine or a costly period of optimization or both.

Then too, there is the last-nine-yards phenomenon. In the summer of 1987, the Adventure Game was running. Users typed French or Latin, and French or Latin appeared in reply. There were obvious deficiencies--the program would refuse to recognize words it had just displayed on the screen, wolves neglected to appear when expected, and an attempt to "pick up the wine" had the curious result that the wine dripped through your fingers and fell to the floor. But twelve people ran the programs for a week without a single system crash, without a single line of Prolog code printed across the screen.

Two years later, the program is still not quite right. We have enlarged the dictionary, expanded the grammar, tuned the logic, added features (like plural quantities), fleshed out the worlds, and--over and over again--we have added rules to the rules and exceptions to the exceptions so that cutting and burning and leading and following have realistic results in our imaginary world. In places, the going is pretty smooth. In particular, the program rarely corrects the user's French or Latin in such a way as to make an incorrect sentence, or a meaningless one, even when the user is a real student. But we still see dialogs like this:

```
› put the bucket in the well

You're not holding the bucket.

› pick up the bucket

You can't pick up the bucket because it's
attached to the well.
```

Eventually, these problems will go away. We have seen so many of their sort come and go that we are utterly confident of eliminating them all...if life proves long enough. The polishing process required by the Adventure Game is after all identical to the one every program undergoes. The difference between the Adventure Game and all our previous programs is that the error space of the Adventure Game is huge, because the recognizable inputs to the program are incalculably numerous. Artificial Intelligence makes it all too easy to build things so ambitious that they run a serious risk of never being finished.

Will we finish this one? Of course. The fascination of the project is as strong now as it was five years ago. Would we start another? With some misgivings. But can we imagine new software for foreign-language learning built along any other lines? Hardly. Artificial Intelligence techniques, for us, and despite an investment of effort we could hardly have imagined at the start, have fulfilled their promise.

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# Research on Computer Anxiety: A Review of the Literature and Suggestions for Future Research Activities

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## Abstract

Teachers must receive training and support in the use of computer technology in the classroom if investments in this technology are to be fully effective. Inservice training in the use of computers must overcome the teachers' varying levels of computer anxiety. Computer anxiety is a barrier to effective use of computers in the classroom. Results of research studies involving computer anxiety generally indicate that there is no correlation between age and computer anxiety; anxiety is reduced with exposure to computers; there is a negative correlation between computer anxiety and prior experience; there is a positive correlation between mathematics anxiety and computer anxiety. Instructors for inservice activities must be aware of factors relating to computer anxiety in teachers and design activities which will aid in reducing the anxiety.

## Introduction

The growing use of various information technologies throughout society has created major new demands for education and training. Widespread use of these technologies, especially computer technology, in the classroom requires that teachers be trained in their uses. More than eight years after the first microcomputers were used in schools, teacher training continues to be a crucial component to the success of any educational technology program (Chaffin, 1988). Although state support for teacher inservice training in the use of computers has been increasing over the years (Bruder, 1988), the majority of teachers have received little training. The report of the Office of Technology Assessment (Power On!, 1988) indicates that only one-third of all K-12 teachers have 10 hours of inservice computer training.

The momentum for computer use in the classroom has increased (Bruder, 1988; Bracey, 1988), but there still remains a certain amount of anxiety about using them. The Office of Technology Assessment reports that one of the barriers to use of computers in the classroom is intellectual - initial fears of using the computer (Power On!, 1988). This report (Power On!, 1988) notes that in order for teachers to feel in control, initial fears about using computers need to be overcome. Once teachers can see that the computer is a tool that can help them do their job and feel comfortable in using the computer, they will try to integrate it into their classes. If teachers are to use computers effectively in the classroom, they must first overcome their anxiety about using the computer. To help teachers overcome this anxiety, one must understand what factors contribute to this anxiety and what experiences will alleviate the anxiety. These factors must be taken into account when planning any program for teacher training in the use of computers. (Power On!, 1988).

### Nature of Computer Anxiety

Anxiety is the result of psychological stress. The consequences of anxiety depend on the demands of the situation and are usually negative.

The concept of anxiety consists of two parts, trait anxiety and state anxiety. Trait anxiety is a relatively stable condition of a proneness to be anxious and is personality related (Jonassen, 1986). State anxiety is situational; it results directly from some stress-producing situation during a finite period of time (Jonassen, 1986).

The term computer anxiety has been used to express the sense of hesitance and fear that people who are unfamiliar with computers can experience. Computer anxiety is generally regarded as an instance of state anxiety rather than trait anxiety and as such is susceptible to changes over time (Cambre & Cook, 1984).

### Research on Computer Anxiety

Some researchers, while assessing measures of computer anxiety, investigated possible correlates of computer anxiety. Others, using general measures of anxiety, studied changes in computer anxiety over time and/or with various treatments and also some of its potential correlates. The studies involving computer anxiety have investigated relationships between the following variables and computer anxiety.

### Exposure to computers

Most studies involving computer anxiety are in agreement that anxiety is reduced with exposure to computers. For example, Powers, Cummings, and Talbott (1973) investigated the relationship between "hands on" computer experience and anxiety levels in volunteer male college students. Subjects were pretested with an anxiety measure after completing a two hour training session. They were then presented with a lecture concerned with the utilization of a computer program and were later asked to work through the computer program. Periodically, while the subjects worked through the program, blood pressure and heart rate measurements were taken. T tests were conducted for the sample over each time interval. Results indicated that continued "hands on" experiences with computers reduced anxiety below the pre-exposure level.

In another example, Honeyman and White (1987) conducted a study in which 38 adults, enrolled in computer literacy classes, were administered the State Trait Anxiety Inventory (STAI) as a pretest, posttest, and mid-term test. Results indicated that anxiety levels changed significantly after 30 hours of contact with the computer.

### Age

Most studies have found no correlation between age and computer anxiety. In a study involving the instructional use of computers conducted by Raub (1981), several anxiety measures were administered to undergraduate students. The control group consisted of 29 students enrolled in an introductory COBOL course. The control group consisted of 21 students enrolled in an introductory psychology course. Raub (1981) conducted a multiple regression analysis with computer anxiety as the dependent variable. Age was eliminated from the equation since no linear relationship with computer anxiety was found.

In the Honeyman and White (1987)study in which 38 adults enrolled in computer literacy classes were administered the State Trait Anxiety Inventory (STAI) as a pretest, posttest, and mid-term test, age had no significant correlation with computer anxiety.

### Sex

The relationship between computer anxiety and sex has been reported with mixed results. In a study conducted by

Jordan and Stroup (1982), sex was used as one of the independent variables. A self-report of computer fearfulness was the dependent variable. The sample consisted of students in a college level introductory data analysis course. Of the three independent variables having an F-ratio greater than 1.0, sex was the greatest discriminator of computer fearfulness.

But in the Honeyman and White (1987) study of change in computer anxiety over time mentioned previously, sex was found to have no significant correlation with computer anxiety.

### Prior experience

Most studies report a negative correlation between computer anxiety and prior experience. The subjects with less computer experience were generally more anxious. For example, Jones and Wall (1985) studied the relationship between computer anxiety and prior experience in a group of 127 undergraduate students enrolled in the same computer class. 55% of the sample reported having no previous training with computers. The Computer Anxiety Index was administered to the students as a pretest and posttest. Pearson correlation coefficients were calculated for pretest posttest anxiety, sex, age, and experience. The relationship between experience and posttest anxiety scores was significant. The subjects with less computer experience were generally more anxious.

Gressard and Lloyd (1987) conducted a study to investigate the effects of mathematics anxiety and sex on computer anxiety. The sample consisted of 356 students from three groups; junior high school, liberal arts college, and community college. The computer experience of the subjects ranged from less than a week to more than one year. The Computer Attitude Scale was used to measure computer attitudes. For each of the three groups, hierarchical regression procedures were performed. With computer experience added to the equation, a significant amount of variance of computer anxiety was explained for all three groups.

### Mathematics Anxiety

Only a few studies have included measurements of mathematics anxiety but those studies do indicate a correlation between mathematics anxiety and computer anxiety. For example, in the previously mentioned study conducted by Raub (1981), several anxiety measures including the Mathematics Anxiety Scale, were administered to undergraduate students. Raub (1981) conducted a multiple regression analysis with computer anxiety as the dependent variable. One of the independent variables was mathematics anxiety. Using a preliminary multiple regression analysis, it was determined that the contribution of mathematics anxiety to computer anxiety was significant.

In the Gressard and Loyd (1987) study previously mentioned in which the effects of mathematics anxiety and sex on computer anxiety were examined, a significant amount of variance of computer anxiety was explained by inclusion of mathematics anxiety in the regression equation.

### Suggestions for further study

The level of computer anxiety will vary for individuals depending upon how much of a threat the computer presents to the individual and how much experience the individual has had with a computer.

There are other factors that might effect initial levels and/or post inservice training levels of computer anxiety. Included in studies should be tests to determine if there are differences in anxiety levels between elementary and secondary teachers, teachers and administrators, or among teachers of different subject areas. If the groups are affected differently, this should be taken into consideration in planning inservice programs, making provisions for each group individually.

Results of studies have indicated that anxiety is reduced with hands-on experience with computers. The "hands-on" experience given to the subjects in the studies includes computer programming, problem solving by using canned computer programs, use of tool software, and examination of instructional software. Usually the experience is of one type and not a variety.

Studies have not been done to determine if there is a relationship between changes in anxiety level and types of "hands-on" experiences presented to subjects. How does subject matter taught in inservice programs affect anxiety? Is there more anxiety about learning programming than use of tool software? Does the sequence in which different types of "hands-on" experiences are presented effect changes in anxiety level? These are questions that should be addressed in future studies. If there are differences, anxiety-elevating experiences should be eliminated or, if they must be presented, adjustments must be made in the way they are taught to take into account the anxiety they will produce.

## Summary

If teachers are to use computers, or any of the new technologies, effectively in the classroom, they must first overcome their fear about using the technologies. To help teachers overcome this fear, one must understand what factors contribute to this fear and what experiences will alleviate the fear. These factors must be taken into account when planning any program for teacher training in the use of the technologies. It is hoped that this paper will contribute to an understanding of current research on computer anxiety and provide a context for determining future research activities.

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# THE EFFECTS OF COMPUTER PROGRAMMING ON PROBLEM-SOLVING SKILLS AND ATTITUDES

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## Abstract

*This study examined the effects of systematic computer programming and problem-solving instruction on problem-solving skills and attitudes. 272 elementary and junior high students were exposed to one of four computer programming and problem-solving treatments for a period of 20 weeks. Elementary students received programming instruction in Logo, while junior high students studied BASIC.*

*Results indicated that computer programming alone was ineffective in teaching problem-solving. However, when paired with systematic problem-solving instruction, learners demonstrated significant learning gains.*

A dramatic revelation of the educational reform movement in the mid eighties was the lack of focus on problem solving and higher-order cognitive skills in the public schools. Partly due to a desire to increase student and teacher accountability and partly to address the "back to basics" challenge, many school systems have neglected problem-solving skills. Nearly 200 calls for curriculum reform issued since 1980 have urged a greater emphasis on higher order cognitive skills, and today, virtually all 50 states are considering such reforms.

Concurrently, the proliferation of microcomputers across the nation has created an added impetus to shift the curriculum away from the "three 'R's," and toward higher cognitive skills. Some have argued that computers have be "sold" as the ideal mechanism for teaching these skills.

To date, a primary computer-related activity used to teach problem-solving has been computer programming, either with BASIC or Logo. Papert (1980) argues that learning computer programming with Logo is an ideal environment for learning problem-solving skills. Other Logo proponents assert that programming fosters problem-solving through "top-down thinking," a problem-solving model, whereby large problems are separated into manageable components that are solved individually and then assembled into the correct solution to the problem (Lawler, 1982a). Papert also argues that programming encourages learners to evaluate their solutions and thinking processes. This metacognitive process allows the student transfer newly acquired problem-solving skills to novel problem situations.

According to Lawler (1982b), programming encourages learners to improve problem solutions. Through "debugging" or "stepwise refinement," learners are able to correct small problems in their procedures and produce a solution to the programming problem.

Research on programming processes supports the use of stepwise refinement and top-down thinking. Through experience, programming experts develop libraries of short programs or "templates" that perform specific program functions (Dalbey & Linn, 1985). Templates might include routines for solving financial calculations, displaying animation sequences, or providing feedback and reinforcement. With practice, experts are able to simplify complicated programming tasks by applying these templates in a top-down fashion. Expert programmers also engage in stepwise refinement to perfect program code.

A significant problem in assessing the efficacy of computer programming activities on learner problem-solving skills is the lack of a widely accepted definition of these skills. According to Kantowski (1977), there exist two distinctly different types of problems typically associated with the study of mathematics: application problems and non-routine problems. Application problems are simple verbal or "word" problems. Learners choose the appropriate solution algorithm and apply it to the problem, often through a relatively simple translation of words into mathematical symbols and equations. When solving non-routine or divergent problems, the learner has no algorithm in his/her repertoire which, when applied, will guarantee the correct solution (Kantowski, 1980). According to Gick (1989), when no algorithm is available, impasse occurs and either the learner generates an algorithm or fails to solve the problem. Open-ended programming problems, that can be solved in a variety of ways, are non-routine problems.

Good planning skills and a repertoire of appropriate solution strategies seem to be key components in non-routine problem-solving skills (Webb, 1979), since in their absence, many learners resort to random trial and error (Lester, 1975; Pintrich, Berger, & Stemmer, 1987). Top-down thinking may provide these planning skills and strategies.

Despite intuitive appeal, there is conflicting evidence on the relationship between computer programming and cognitive skills. Although several studies have suggested that Logo use improves problem-solving skills (Boecker & Fischer, 1982; Clements, 1986; Clements & Gullo, 1987; Degelman, Free, Scarlato, Blackburn, & Golden, 1986; and Gorman, 1982), other authors assert that cognitive benefits of programming are a function of the structure applied with programming activities (Lehrer, Harckman, Archer, & Pruzek, 1986; Lehrer & Randle, 1987; Miller & Emihovich, 1986; Pea & Kurland, 1984; Perkins & Hancock, 1986).

Unfortunately, most evidence supporting the cognitive effects of Logo has been anecdotal, based on small samples of students, and often non-empirical in nature (Khayrallah & Van Den Meiraker, 1987). Recent empirical studies do not support the use of computer programming as a means of developing logical thinking skills (Blume & Schoen, 1988; Jansson, Williams, & Collens, 1987), skills of planning and problem solving (Pea & Kurland, 1983), or as a means of accelerating the cognitive development of young children (Howell, Scott, & Diamond, 1987).

Another significant issue surrounding the teaching of problem-solving skills via computer programming is generalizability of skills acquired. Papert has suggested that problem-solving skills fostered by Logo not only transfer to new problems within the Logo context, but also transfer to learning environments outside Logo. However, research suggests that spontaneous transfer of problem-solving skills gained through programming to other domains is unlikely and formal instruction on how to apply strategies to new domains may be needed (Clement, Kurland, Mawby, & Pea, 1986; Salomon & Perkins, 1987).

Many authors have expressed concern about the inequitable access of male and female learners to computer resources (LaPointe & Martinez, 1988). Gender differences in programming may compound observed inequities in math and math-related content areas. However, despite a volume of gender difference research (Fennema, 1981), little research has been conducted on gender effects related to computer programming and problem-solving.

It has also been suggested that Logo programming improves learner attitudes towards instruction (Lawler, 1982c; Markuson, Tobias, & Lough, 1983). According to Papert, computer programming with Logo defies the application of the traditional right/wrong dialectic, and since learners are not subjected to right/wrong "all or nothing" judgements, they feel less demeaned and develop more positive attitudes towards learning (cf., Papet, 1980). This assertion is at least partly supported by recent research in attribution theory and motivation (Keller & Suzuki, 1988). However, research testing this assumption has often been confounded by novelty effects from short-term computer interventions.

More research is needed to determine the efficacy of computer programming activities on improving problem-solving skills and attitudes. This study investigated the effects of structured computer programming activities, supplemented with problem-solving strategy instruction, on programming skills, learner attitudes toward , problem-solving skills.

## METHOD

### Subjects

The subjects used in this study were 272 elementary and junior high school students from a suburban school district. The sample consisted of 166 fifth and sixth grade students and 106 seventh and eight graders. There was an approximately equal distribution of male (52%, n = 141) and female learners (48%, n = 131). Ethnic composition of the group was primarily Anglo, with some minority representation.

Learners were assigned by class to one of four programming and problem-solving conditions. A total of 22 classes, lead by 15 teachers in three schools parcipated in the study.

### Materials

The basic instructional material used in this study consisted of 20 print-based interactive self-instructional modules on computer programming in either the BASIC or Logo programming languages, and 13 print-based self-instructional modules on problem-solving strategies.

*Computer Programming Materials*

*Logo modules*. Elementary learners were provided with a series of 20 print-based self-instructional tutorial modules on the Logo programming language on the IBM-PC. Learners were provided with a new module each week and were given approximately 50 minutes during a regularly allocated math period to complete the lesson. Each new lesson was placed in a binder containing previous modules, allowing learners to review previous material as required.

Each module was designed to be completed while actually entering commands at the keyboard. Examples of the modules included: "Getting Started with Turtles," a tutorial on the operations of the microcomputer system; "Primitive Turtles," an introduction to the Logo primitive commands, "Turtle Pen Pals," a description of Logo pen controlling commands; and "Cursing Superturtles," a description of recursion in Logo. Two of these 20 modules were review lessons on commands and concepts presented by other modules.

Each of the modules was designed to build upon and follow the information and concepts presented by previous modules. Modules were designed according to the Events of Instruction (Gagné, 1985). Specifically, each began with an attention getting graphic and title, followed by a brief statement of the objective of the lesson, a review of the previously learned commands, and a brief listing of the new commands and concepts contained in the module.

Each lesson then presented the learners with a problem to solve using the new commands. Pertainent short-cuts or hints were provided as learner guidance, followed by a print-based description of a possible solution to the problem as a self-check. Learners were then asked to write a definition for the command and check their answers against the key provided. Finally, a set of practice problems was provided, along with a difficult extension problem. Each lesson also contained visual cues in the form of simple line drawings to provide additional motivation and hints as to the structure and content of the module.

Learners worked either individually or in pairs and teachers acted only as supervisors and troubleshooters during the lesson time, providing no formal instruction to supplement the materials.

*Basic modules*. Junior high learners were provided with a series of 20 print-based self-instructional tutorial modules on the BASIC programming language on the IBM-PC. These modules were designed in a fashion parallel to that of the Logo modules described above. Examples of the BASIC modules included: "The Starting Steps of BASIC," a tutorial on the operations of the microcomputer system and a guide to starting BASIC on the PC; "Writing a Program," a description of line numbering, and running and listing BASIC programs, "The Ever-changing Variable," a description of BASIC variable types; and "BASIC 'Rithmetic," a description of mathematical operators in the BASIC language. As with the Logo lessons, two of these 20 modules were review lessons on commands and concepts presented by other modules.

As with the Logo lessons, learners worked either individually or in pairs and teachers served only to answer questions regarding the materials and the operation of the delivery system.

### *Problem-Solving Materials*

Problem-solving materials included 13 self-instructional tutorial modules on problem-solving strategies, adapted from *The Productive Thinking Program* (Covington, Crutchfield, Davies, & Olton, 1973). Examples of these modules included: "Try the Impossible," which encouraged creative solutions as a brainstorming activity; "New Ideas," which focused on changing perspectives on a problem's solution; "Finding New Problems," which examined changing the context of problems to seek the real problem; and "Gathering Evidence," which taught ways to collect solution data.

Learners were provided with a new module each week during a regularly scheduled social studies period, with the exception of the culminating module, "Building a City," which required two periods to complete. The format of each module consisted of a series of short problems, followed by explorations and questions designed to provide practice with the particular problem-solving strategy. Typically, learners worked individually on the materials for the first 30-35 minutes of the allotted time. Teachers then lead a debriefing period were the module activities and strategies were reviewed and summarized.

## Dependent Measures

At the conclusion of the 20 week experimental period, all learners were given four dependent measures: problem-solving posttest, a computer programming concepts posttest, an attitude toward computers survey, and an attitude toward problem-solving survey.

### *Problem-Solving Posttest*

The problem-solving posttest consisted of 25 multiple choice questions designed to measure learners problem-solving ability. A sample item was: "There are 19 vehicles in the parking lot. If there are 62 wheels, how many of the vehicles are motorcycles?" Split-half reliability of the revised scale was found to be a = 0.78, using data gathered during this study.

### *Programming Posttest*

Corresponding to the two sets of materials, Logo and BASIC, utilized with the elementary and junior high groups, respectively, two separate programming posttests were developed.

*Logo posttest.* Elementary learners were given a 20-item multiple choice posttest on Logo commands and concepts. For example, learners, when given a definition, were asked to simply select from a list of appropriate commands: "Which command moves the turtle in the direction it's facing? (a) FD, (b) BK, (c) UP, and (d) FR." In addition, learners were asked to apply Logo commands to predict procedure outcomes: "Which of the following procedures will draw three squares in a row?" Split-half reliability of this instrument was found to be a = 0.82 using data collected during the study.

*BASIC posttest.* Junior high learners were given a 20-item multiple choice posttest on BASIC commands and concepts. As with the Logo posttest, this test contained both simple information and rule application questions. Examples of items included: "The command which erases the screen is: (a) CLEAR, (b) NEW, (c) HOME, and (d) CLS" and "The command to allow the user to type something at the keyboard is: (a) TYPE, (b) INPUT, (c) READ, and (d) DATA." Split-half reliability of this instrument was found to be a = 0.65 using data collected during the study.

### *Attitude Toward Computers Survey*

All learners were given a 20-item 5-part Likert survey on attitudes toward computers. Learners were asked to respond to items such as "I feel very comfortable around computers" and "I don't like computers and it scares me to have to work on them" on a five-part scale, ranging from "Strongly Disagree" to "Strongly Agree." The survey contained equal numbers of positively and negatively worded items to encourage careful reading of items. Split-half reliability of this instrument was found to be a = 0.92 using data collected during the study.

### *Attitude Toward Problem-Solving Survey*

All learners were given a 10-item 5-part Likert survey on attitudes toward problem-solving. Examples of items on this measure were: "I think my problem-solving has improved this year" and "I like to work on difficult problems." Learners were asked to respond to the items on a five-part scale, ranging from "Strongly Disagree" to "Strongly Agree." The survey contained equal numbers of positively and negatively worded items to encourage careful reading of items. Split-half reliability of this instrument was found to be a = 0.80 using data collected during the study.

## Procedures

Prior to the beginning of the study teachers were briefed on procedures to be followed during data collection. Learner cummulative records were used to obtain the previous year's Iowa Test of Basic Skills (ITBS) total math and composite scores for use as covariates in subsequent data analysis.

Learners were assigned by class to one of the following four treatment conditions: computer programming with problem-solving strategy instruction, computer programming without problem-solving strategy instruction, problem-solving strategy instruction only, and a control group.

### *Computer Programming with Problem-Solving Strategy Instruction (CP + PS)*

This treatment condition consisted of 20 weekly computer programming modules, either in Logo or BASIC, depending on school level, as described above. During a regularly scheduled math period, learners worked either individually or in pairs to complete each module by entering commands and solving provided problems on a microcomputer.

In addition to the computer programming activities, learners received the 13 print-based problem-solving strategy modules during 14 regularly scheduled social studies periods, as previously described.

### *Computer Programming Instruction Only (CP)*

Learners in this treatment received only the 20 programming modules described. Learners were provided with conventional social studies content and no problem-solving strategy instruction.

### *Problem-Solving Strategy Instruction Only (PS)*

In this treatment, learners received only the 13 problem-solving modules during their social studies class. Regular mathematics instruction was provided during their math periods.

### *Control*

In the control treatment, learners received conventional instruction during both math and social studies periods. No computer programming or problem-solving strategy materials were used with these learners during the experimental period.

At the conclusion of the experimental period, learners were given the dependent measures described during regular class time over a two-day period. Learners were given enough time to attempt all items on all four measures.

## Experimental Design and Data Analysis

Preliminary analyses showed no significant teacher or class-related effects and data were collapsed across these factors. Separate analyses were conducted for data collected on elementary and junior high samples. Both analyses employed completely crossed 2 x 2 x 2 programming by problem-solving by gender block factorial designs featuring two levels of computer programming treatment (programming and no programming), two levels of problem-solving strategy instruction (problem-solving and no problem-solving), and two-levels of gender (male and female).

Dependent measures included a problem-solving posttest, a programming posttest, an attitude toward computers survey, and an attitude toward problem-solving survey. Data from this study was analyzed using multivariate analysis of covariance (MANCOVA) procedures, using ITBS math and composite scores, and learner grade level as covariates. Follow-up univariate analysis of covariance (ANCOVA) procedures were performed on significant factors, using the Bonferroni correction. Significant two- and three- way interactions were subjected to the Neuman-Keuls multiple comparison technique.

## ELEMENTARY RESULTS

Preliminary MANOVA results produced no significant gender effects were detected ($F(4,152) = 0.79$, $p = 0.53$). However, significant effects were found for both the problem-solving and programming treatments ($F(4,152) = 3.96$, $p < 0.001$ and $F(4,152)$, $= 4.58$,$p < 0.001$, respectively). In addition, a significant interaction between problem-solving treatment and programming treatment was present ($F(4,152) = 3.18$, $p = 0.01$). Neither of the two-way interactions involving gender (gender by problem-solving treatment or gender by programming treatment) was significant ($F(4,152) = 2.07$, $p = 0.08$ and $F(4,152) = 1.30$, $p = 0.27$, respectively), nor was the three-way interaction between gender, problem-solving treatment, and programming treatment ($F(4,152) = 1.68$, $p = 0.15$).

### *Problem-Solving Posttest*

Cell statistics for the elementary problem-solving posttest are contained in Table 1. The mean of the problem-solving treatment group, 56.49, and the mean of the non-problem-solving control, 49.84 were not statistically different ($F(1,155) = 0.03$, $p > 0.05$), nor were the means of the programming group and the non-programming control, 53.35 and 52.69, respectively ($F(1,155) = 2.99$, $p > 0.05$). However, a significant two-way interaction between programming treatment and problem-solving treatment was present ($F(1,155) = 8.13$; $p < .01$). This interaction is shown in Figure 1.

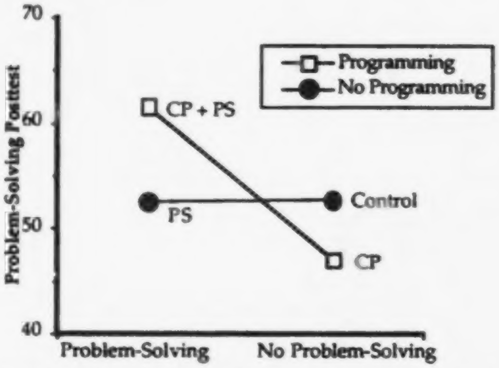

Figure 1. *Elementary problem-solving posttest scores.*

### *Programming Posttest*

Cell statistics for the elementary programming posttest are contained in Table 1. The mean of the problem-solving treatment group, 49.97, was significantly greater than the mean of the non-problem-solving control, 46.70 ($F(1,155) = 13.57$, $p < 0.01$), and the mean of the programming group, 56.61, was significantly greater than the mean of the non-programming control, 40.67, respectively ($F(1,155) = 69.27$, $p < 0.001$). In addition, a significant programming treatment by problem-solving treatment interaction was detected ($F(1,155) = 8.36$; $p < 0.01$). This interaction is shown in Figure 2.

**Table 1.** *Elementary results.*

| Problem-Solving Treatment | | | Prob-Solving Posttest | | | Programming Posttest | | | Attitudes Toward Computers | | | Attitudes Toward Prob.-Solving | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Prog | Cont | Total | Prog | Cont | Total | Prog | Cont | Total | Prog | Cont | Total |
| PS | Male | Mean | 62.44 | 53.64 | 57.41 | 57.20 | 51.04 | 53.68 | 41.28 | 42.88 | 43.09 | 37.58 | 40.32 | 39.15 |
| | | n | 18 | 24 | 42 | 18 | 24 | 42 | 18 | 24 | 42 | 18 | 24 | 42 |
| | Female | Mean | 60.76 | 51.41 | 55.45 | 54.08 | 39.4 | 45.75 | 36.71 | 41.30 | 39.31 | 33.72 | 35.93 | 34.98 |
| | | n | 16 | 21 | 37 | 16 | 21 | 37 | 16 | 21 | 37 | 16 | 21 | 37 |
| | Total | Mean | 61.65 | 52.60 | 56.49 | 55.73 | 45.61 | 49.97 | 40.23 | 42.14 | 41.32 | 35.77 | 38.27 | 37.19 |
| | | n | 34 | 45 | 79 | 34 | 45 | 79 | 34 | 45 | 79 | 34 | 45 | 79 |
| Control | Male | Mean | 47.64 | 49.54 | 48.63 | 61.16 | 34.78 | 47.37 | 41.28 | 40.28 | 40.75 | 38.75 | 36.29 | 37.48 |
| | | n | 21 | 23 | 44 | 21 | 23 | 44 | 21 | 23 | 44 | 21 | 23 | 44 |
| | Female | Mean | 46.6 | 56.73 | 51.08 | 53.86 | 36.09 | 46.01 | 37.73 | 41.21 | 39.27 | 34.90 | 35.47 | 35.15 |
| | | n | 24 | 19 | 43 | 24 | 19 | 43 | 24 | 19 | 43 | 24 | 19 | 43 |
| | Total | Mean | 47.08 | 52.79 | 49.84 | 57.26 | 35.37 | 46.70 | 39.39 | 40.70 | 40.02 | 36.71 | 35.92 | 36.33 |
| | | n | 45 | 42 | 87 | 45 | 42 | 87 | 45 | 42 | 87 | 45 | 42 | 87 |
| TOTAL | Male | Mean | 54.47 | 51.63 | 52.92 | 59.33 | 43.08 | 50.45 | 42.24 | 41.61 | 41.90 | 38.23 | 38.35 | 38.30 |
| | | n | 39 | 47 | 86 | 39 | 47 | 86 | 39 | 47 | 86 | 39 | 47 | 86 |
| | Female | Mean | 52.26 | 53.94 | 53.10 | 53.95 | 37.83 | 45.89 | 37.32 | 41.25 | 39.29 | 34.43 | 35.71 | 35.07 |
| | | n | 40 | 40 | 80 | 40 | 40 | 80 | 40 | 40 | 80 | 40 | 40 | 80 |
| | Total | Mean | 53.35 | 52.69 | 53.01 | 56.61 | 40.67 | 48.25 | 39.75 | 41.45 | 40.64 | 36.35 | 37.14 | 36.74 |
| | | n | 79 | 87 | 166 | 79 | 87 | 166 | 79 | 87 | 166 | 79 | 87 | 166 |

Table 2. *Junior High results.*

| Problem-Solving Treatment | | | Prob-Solving Posttest | | | Programming Posttest | | | Attitudes Toward Computers | | | Attitudes Toward Prob.-Solving | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Prog | Cont | Total | Prog | Cont | Total | Prog | Cont | Total | Prog | Cont | Total |
| PS | Male | Mean | 79.90 | 76.53 | 78.72 | 45.06 | 43.94 | 44.67 | 46.01 | 48.01 | 46.71 | 40.92 | 43.64 | 41.86 |
| | | n | 13 | 7 | 20 | 13 | 7 | 20 | 13 | 7 | 20 | 13 | 7 | 20 |
| | Female | Mean | 70.70 | 72.60 | 71.38 | 49.11 | 43.12 | 46.95 | 41.77 | 41.53 | 41.68 | 38.22 | 42.64 | 39.82 |
| | | n | 16 | 9 | 25 | 16 | 9 | 25 | 16 | 9 | 25 | 16 | 9 | 25 |
| | Total | Mean | 74.82 | 74.32 | 74.64 | 47.29 | 43.48 | 45.94 | 43.67 | 44.37 | 43.92 | 39.42 | 43.08 | 40.72 |
| | | n | 29 | 16 | 45 | 29 | 16 | 45 | 29 | 16 | 45 | 29 | 16 | 45 |
| Control | Male | Mean | 54.76 | 43.19 | 49.47 | 14.00 | 3.19 | 9.06 | 33.59 | 24.35 | 29.36 | 32.02 | 20.66 | 26.82 |
| | | n | 19 | 16 | 35 | 19 | 16 | 35 | 19 | 16 | 35 | 19 | 16 | 35 |
| | Female | Mean | 57.17 | 42.51 | 48.71 | 19.34 | 8.36 | 13.00 | 31.95 | 25.77 | 28.39 | 30.02 | 19.03 | 23.68 |
| | | n | 11 | 15 | 26 | 11 | 15 | 26 | 11 | 15 | 26 | 11 | 15 | 26 |
| | Total | Mean | 55.64 | 42.86 | 49.15 | 15.96 | 5.69 | 10.74 | 32.99 | 25.04 | 28.95 | 31.29 | 19.87 | 25.48 |
| | | n | 30 | 31 | 61 | 30 | 31 | 61 | 30 | 31 | 61 | 30 | 31 | 61 |
| TOTAL | Male | Mean | 64.95 | 53.34 | 60.11 | 26.62 | 15.60 | 22.01 | 38.63 | 31.55 | 35.67 | 35.63 | 27.65 | 32.29 |
| | | n | 32 | 23 | 55 | 32 | 23 | 55 | 32 | 23 | 55 | 32 | 23 | 55 |
| | Female | Mean | 65.18 | 53.79 | 59.82 | 36.98 | 21.39 | 29.65 | 37.77 | 31.68 | 34.91 | 34.88 | 27.88 | 31.59 |
| | | n | 27 | 24 | 51 | 27 | 24 | 51 | 27 | 24 | 51 | 27 | 24 | 51 |
| | Total | Mean | 65.07 | 53.57 | 59.97 | 31.36 | 18.56 | 25.68 | 38.24 | 31.62 | 35.30 | 35.29 | 27.79 | 31.95 |
| | | n | 59 | 47 | 106 | 59 | 47 | 106 | 59 | 47 | 106 | 59 | 47 | 106 |

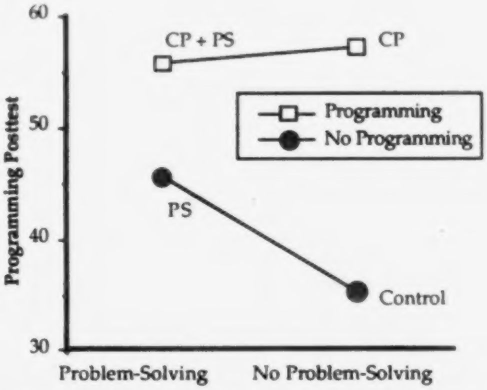

Figure 2. *Elementary programming posttest scores.*

*Attitudes Toward Computers*

Cell statistics for the elementary attitudes toward computers survey are contained in Table 1. The mean of the problem-solving treatment group, 41.32, and the mean of the non-problem-solving control, 40.02, were not statistically different (*F*(1,155) = 1.42, *p* > 0.05), nor were the means of the programming group and the non-programming control, 39.75 and 41.45, respectively (*F*(1,155) = 1.51, *p* > 0.05). In addition, no significant two-way interactions between programming treatment and problem-solving treatment was present (*F*(1,155) = 0.00; *p* > .05).

*Attitudes Toward Problem-Solving*

Cell statistics for the elementary attitudes toward problem-solving survey are contained in Table 4. The mean of the problem-solving treatment group, 37.19, was significantly greater than the non-problem-solving control, 36.33 (*F*(1,155) = 3.94, *p* < 0.05). However, the mean of the programming group, 36.35, was not significantly different than the mean of the non-programming control, 37.14, respectively (*F*(1,155) = 1.97, *p* > 0.05). In addition, the two-way interaction between programming treatment and problem-solving treatment was not significant (*F*(1,155) = 2.39; *p* > .05).

## JUNIOR HIGH RESULTS

The results of the preliminary multivariate analysis of covariance for the junior high dependent measures detected significant multivariate effects for problem-solving treatment (*F*(4,92) = 21.27, *p* = 0.00), programming treatment (*F*(4,92) = 6.91, *p* = 0.00), and the interaction between problem-solving treatment and programming condition (*F*(4,92) = 13.19, *p* = 0.00).

*Problem-Solving Posttest*

Cell statistics for the junior high problem-solving posttest are contained in Table 2. The mean of the problem-solving treatment group, 74.64, and the mean of the non-problem-solving control, 49.15, were significantly different (*F*(1,95) = 6.11, *p* < 0.05). The means of the programming group and the non-programming control, 65.07 and 53.57, respectively, also differed significantly (*F*(1,95) = 17.13, *p* < 0.001).

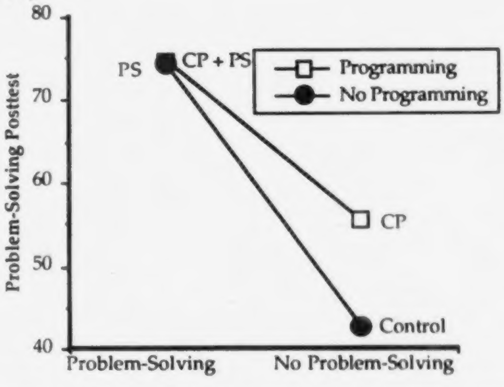

Figure 3. *Junior High problem-solving posttest scores.*

In addition, there was a significant two-way interaction between programming treatment and problem-solving treatment ($F(1,95) = 6.39$; $p < 0.01$). The means are depicted graphically in Figure 3.

*Programming Posttest*

Cell statistics for the junior high programming posttest are contained in Table 2. The mean of the problem-solving treatment group, 45.94, and the mean of the non-problem-solving control, 10.74 were significantly different ($F(1,95) = 7.92$, $p < 0.01$). The means of the programming group and the non-programming control, 31.36 and 18.56, respectively, also differed significantly ($F(1,95) = 10.82$, $p < 0.01$). However, the two-way interaction between programming treatment and problem-solving treatment was not significant ($F(1,95) = 2.06$; $p > 0.05$).

*Attitude Toward Computers Survey*

Cell statistics for the junior high attitude toward computers survey are contained in Table 2. The mean of the problem-solving treatment group, 43.92, and the mean of the non-problem-solving control, 28.95 were significantly different ($F(1,95) = 7.04$, $p < 0.05$). The means of the programming group and the non-programming control, 38.24 and 31.62, respectively, also differed significantly ($F(1,95) = 17.68$, $p < 0.001$). In addition, there was a significant two-way interaction between programming treatment and problem-solving treatment ($F(1,95) = 9.18$; $p < 0.001$). The means are shown in Figure 4.

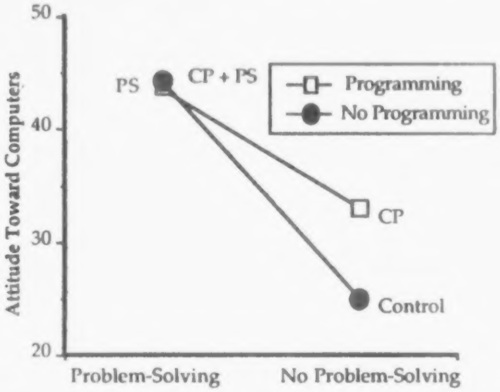

**Figure 4.** *Junior High attitudes toward computers results.*

*Attitude Toward Problem-Solving Survey*

Cell statistics for the elementary attitude toward problem-solving survey are contained in Table 2. The mean of the problem-solving treatment group, 40.72, and the mean of the non-problem-solving control, 25.48 were significantly different ($F(1,95) = 16.29$, $p < 0.001$). The means of the programming group and the non-programming control, 35.29 and 27.79, respectively, also differed significantly ($F(1,95) = 61.51$, $p < 0.001$). In addition, there was a significant two-way programming treatment by problem-solving treatment interaction ($F(1,95) = 44.86$; $p < 0.001$). The means are depicted graphically in Figure 5.

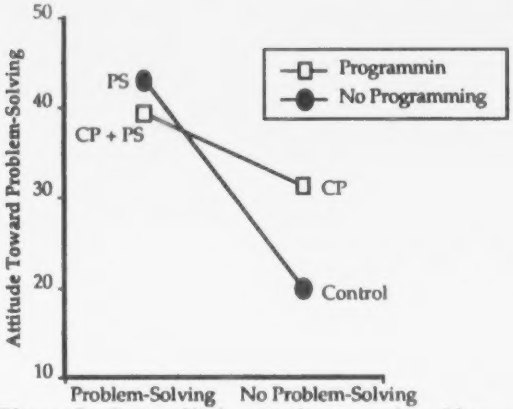

**Figure 5.** *Junior High attitudes toward problem-solving results.*

## DISCUSSION

A significant programming treatment by problem-solving treatment interaction was found on the elementary problem-solving measure. Learners exposed to both learning experiences performed significantly better than learners in the problem-solving or programming only treatments. On this measure, learners in the programming only group actually scored significantly lower than the control.

Learners involved in the programming treatments lost one period of math lessons per week for the duration of the study. The results on the problem-solving posttest suggest that learners in the control group, exposed to their regular math program, actually gained more problem-solving skills than were gained by the computer programming lessons alone. However, when supplemented by additional problem-solving stratgy instruction, learners showed impressive gains. This finding supports previous research that suggests problem-solving skills are improved through repeated practice (Kantowski, 1974). One of the presumed benefits of computer-activities in general is the increased interactivity with the content (Dalbey, Tourniaire, & Linn, 1986). The results of this study suggest that the computer activities may have provided an ideal practice medium for the problem-solving strategies taught in the problem-solving treatment.

The combination of computer programming and problems-solving instruction was not as powerful for junior high learners using BASIC. In fact, learners in the computer programming with problem-solving treatment were statistically equivalent to learners in the problem-solving only treatment. Unlike the elementary treatment, the computer did not seem to provide an adequate practice environment for the problem-solving stratgies. Several factors may account for this difference. Many of the learners at this level had some prior exposure to BASIC at their elementary schools. Many were convinced that they had sufficient command of the language to skip much of the instruction and move to practice opportunities directly. A lack of sufficient monitoring by teachers and the emphasis on self-study of the materials may have accounted for some failure to follow directions.

In addition, learners reported considerably more difficulty in mastering the syntax and commands of BASIC than elementary learners experienced with Logo. Some researchers assert that transfer of problem-solving skills gained through programming can occur even without language mastery as long as sufficient instruction and practice within the transfer domains is provided (Salomon, & Perkins, 1987). Others argue that a prescribed "chain of cognitive accomplishments" occurs, through which learners move from learning specific features of the language to applying templates to procedural skills, to generalizable problem-solving skills (Linn, 1985; Linn & Dalbey, 1985; Mandinach & Linn, 1986). Other researchers note that mastering programming to a level where generalizable problem-solving skills are learned is a long and arduous process (Mandinach & Linn, 1987; . The results of this study support the notion that, without specific instruction, learners struggling with specific language characteristics will not easily progress to higher cognitive skills. These results also support Logo proponents who argue that Logo provides and easy entré to programming that facilitates learning of problem-solving skills.

Gagné [34] notes that cognitive strategies often tend to be domain specific, inhibiting transfer from one content area to another. A variety of researchers assert that spontaneous transfer of problem-solving skills across domains is unlikely, and that the skills required to solve "real-life" problems are so general that they are practically unteachable. In this study, the problem-solving treatment produced significant improvements in problem-solving skills on a test closely correlated to those skills—a near transfer task.

Other researchers have asserted that failures to find far transfer may be due to the low level of students' programming expertise [43]. The short duration of this intervention prevented sufficient mastery of BASIC. Given this limitation, was the computer programming treatment successfull in teaching problem-solving skills? Did far transfer occur? Apparently, the strategies fostered through programming did encourage this transfer marginally. However, given the amount of time and resources required, this marginal improvement may not justify the costs of computer programming interventions if their only purpose is teaching problem-solving skills.

At both the elementary and junior high levels, the programming treatment had a strong effect on teaching programming skills. This results comes as no surprise. Given the amount of time (20 instructional periods), it seems reasonable to expect that a well-structured intervention would be successful when compared to no intervention. However, the marginal improvement produced by the junior high materials strongly suggests that BASIC is a far more difficult language to learn and more developmental work is required for this type of intervention to work more effectively. These results suggest that requiring learners to master BASIC programming through self-study may be unrealistic unless accompanied by considerable teacher support and additional practice opportunities.

The most interesting result related to the programming outcomes is that strategies fostered through the problem-solving materials apparently helped learners learn programming. It seems unlikely that problem-solving activities helped learners with the verbal information command translations. However, these results suggest that generalizable problem-solving may help students organize and solve programming problems. Generalizable problem-solving strategies may transfer to the specific contexts of learning to program a computer. This result supports the construct of subsumption, whereby learning more difficult or generic tasks often requires the learner to attain or infer necessary component sub-skills. If computer programming at a rudimetary level consists of only two or three distinct strategies, learning a battery of such strategies may foster subsumption of these limited strategies.

Although the problem-solving treatment produced significantly greater scores on the attitude toward problem-solving measure, no significant effects were observed at the elementary level on the attitude toward computers survey. This result may have been caused by a diffusion effect. The elementary subjects used in this study were also involved in a number of other computer-related activities, including computer-assisted instruction and computer applications, primarily word processing. Therefore, little difference in computer exposure existed between various experimental groups. Attitudes were universally high across treatment conditions for these learners when compared with their junior high age counterparts: 40.64 vs. 35.30.

At the junior high level, the programming treatment had a positive effect on attitude toward computers. However, the problem-solving materials produced much more positive effects. It seems probable that perceived improvement in problem-solving skills leads to a belief in computer programming skills, as well as an improvement in overall attitude. This result supports Keller's (Keller & Suzuki, 1988) assertion that belief in success potential (self-efficacy) is an important determinant in affect.

On the attitude towards problem-solving measure, learners in the problem-solving treatment expressed more favorable attitudes than learners not exposed to these materials. This results, coupled with the efficacy of these materials, suggests that these materials may have also produced improved perceptions of self-efficacy. At the junior high level, the programming treatment was also somewhat successful in improving learner attitudes toward problem-solving. This effect may be due to the perception held by many students, and encouraged by the nature of the study, that computers are "for" solving problems.

In summary, this study demonstrated that structured problem-solving strategies can be effective in teaching generalizable problem-solving skills and in improving learner attitudes toward instruction. However, computer programming was much less effective in teaching these skills. Further, the results of this study suggest that computer programming and problem-solving strategy instruction, when used together, may provide an effective means of teaching transferrable problem-solving skills.

Future research should explore the combination of generic strategies which are most effective in creating a repertoire of useful strategies that apply across domains. Finally, future development efforts should explore ways in which computer-based activities can be used to deliver instruction on problem-solving strategies.

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# The Slighted Side of the Usability Equation: Effects of Computer Documentation on Students' Use of Computer Programs

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## Abstract

*This study investigated the effects of a minimal manual version versus a cards version of documentation on students' computing behaviors while learning to use a telecommunication system, students' attitudes toward the documentation, and students' later use of the system. Guidelines from the work of Carroll and colleagues at the IBM Watson Research Center and Reder and colleagues from Carnegie Mellon University were followed when developing the two versions of the documentation. Subjects were 74 junior and senior college-level students enrolled in a technical writing course. Results showed that students in both treatments completed the tasks and felt that the documentation was relatively easy to use. There were significant differences, however, in the students' manual/display coordination, in their ratings of the instruction, and in their later use of the system. The central implication of the study is that CBI documentation needs to center on the learner's goals instead of on the system or the concepts that are being taught.*

Effective computer programs make learners active participants instead of passive absorbers of the content being studied. Effective computer documentation should also allow learners to create, explore, and integrate knowledge as they use a computer system. While computer programs as a whole are improving, the documentation that accompanies the programs often lags far behind in terms of centering on learners' needs. While many computer programs allow learners to manipulate concepts and to study a myriad of hypothetical situations simultaneously, if learners cannot easily access programs and use them to meet their goals and needs, insight is replaced by frustration.

### *Computer Documentation*

During the 1980's, researchers at centers such as the Document Design Center in Washington, D.C. (Redish, 1986; Redish, Battison, & Gold, 1985), the Communications Design Center at Carnegie Mellon University (Duffy, Trumble, Isenberg, Janik, & Rodgers, 1987; Schriver, 1984, 1986), and the IBM Watson Research Center (Carroll & Mack, 1987; Carroll & Rosson, 1985; Carroll, Smith-Kerker, Ford, & Mazur-Rimetz, 1987-88) have studied the problem of training users in the use of computer programs. John M. Carroll and colleagues (1987-88) at the IBM Watson Research Center have broken down the training problem into the following list of user-specific problems which they have seen numerous times:

1. Users are overwhelmed by learning tasks
2. Users jump the gun or plunge into procedures as soon as they are mentioned instead of reading explicit warnings or suggestions
3. Users skip or flip past any information that cannot be directly executed on the screen
4. Users trust their reason and intuition instead of reading documentation
5. Users read a step, carry it out, and then read the next step without checking to see if the step worked on the program
6. Users have trouble recovering from errors because the documentation assumes that users will not make errors
7. Users want to do real work instead of finishing a program and thinking, "What did I do or learn?"

### *The Minimalist Training Model*

In response to these problems, Carroll et al. (1987-88) developed and tested what they call a Minimalist Training Model, a model that accommodates and capitalizes on user learning styles and strategies. The three main premises for developing documentation that follow the minimalist training model are to focus on real tasks and activities, to slash the verbiage, and to support error recognition and recovery.

Carroll et al. conducted a series of studies in which they compared minimal manuals to commercially developed self-instruction manuals (1984, 1985, 1987-88). Invariably they have found that minimal manuals help learners better coordinate their attention between the system and the manual, better recognize and recover from errors, and better support reference use after training.

### *Cards as Documentation*

In an earlier set of studies, Carroll et al. (1984, 1985) advocated a Guided Exploration approach. In order to test how users guided their exploration of a computer program, Carroll et al. designed a set of brief cards to replace a commercial self-instruction manual. The cards stressed real user tasks such as "typing something" instead of "practicing with the status line," and the cards contained about an eighth as much verbiage as the original manual.

Results showed that learners who used the cards, as compared to learners who had used the original manual, spent less than half as much time in learning to use the program, spent less than a third as much time reading, made half as many errors, and recovered significantly more often from their errors. Despite the significant differences in favor of the cards version of the documentation, the learners who received the cards expressed a distinct desire for documentation that looked more structured or that had the look and feel of a more traditional manual.

### *Textual Elaborations in Documentation*

In response to whether computer manuals should be minimalist and contain only information that is absolutely necessary, or maximalist and fully explain unfamiliar concepts and procedures, Reder and colleagues (1984, 1986, 1987) have also researched the optimal design of computer documentation. Specifically, they focused on the informational content of the manuals and on the role of textual elaborations.

They define textual elaborations as "any information that supports, clarifies, or further specifies the main points of a text" (Reder, Charney, & Morgan, 1986, p. 64). Elaborations can take many forms such as examples, details, analogies, restatements, and deductions. An author can include elaborations in the text itself in order to elaborate on the main ideas or concepts, or the reader can elaborate on the text independently while reading. In either case, elaborations help students learn and remember the main ideas of a text because they help students create more connections to their prior knowledge.

Reder, Charney, and Morgan (1986) investigated the effects of text elaborations on learners' understanding of new concepts and procedures, their actual executing of the procedures, and their recognition as to when each procedure was appropriate for solving a problem. Unlike Carroll's work, Reder et al. incorporated follow-up measures as they believed that the effectiveness of a manual could not be judged by performance during training alone. Their overall results showed that elaborations about executing procedures helped learners solve problems more quickly than minimal manuals that did not include such elaborations. Specifically, they found that syntactic elaborations that illustrated how correct commands should look helped learners determine exactly how to implement a procedure. They concluded that both the minimalist position and the maximalist positions are too extreme and that some elaboration is needed.

As with Carroll and Reder and their colleagues, I have also watched learners become frustrated with learning how to use the computer programs that are expected to aid their learning. Therefore, I conducted an experiment in which I compared the effects of a minimal manual with some elaborations versus a cards version of the manual on students' computing behaviors, their attitudes toward the documentation, and their later use of the computer system.

## Method

### *Subjects*

The subjects were 74 junior and senior college-level students enrolled in four sections of a technical writing course titled Writing in Your Profession. All students were enrolled in "computer use" sections of the course which meant that students met two or three times a week in a classroom equipped with 13 Macintosh computers on an Appletalk network. These computers were also connected to the wider university telecommunication network via Appleshare software, and a computer with a 120 megabyte hard disk functioned as the file server.

Thirty-eight students received a minimal manual with some textual elaborations, and 36 students received a cards version as documentation for using the Appleshare telecommunication system. No significant differences were found among the groups on age, teacher ratings, or previous computer experiences, and no students had previously used a telecommunication system.

### *Design of the Minimal Manual*

In designing the minimal manual, I followed Carroll et al.'s (1987-88) three step process by focusing on real tasks and activities, slashing the verbiage, and supporting error recognition and error recovery. I also followed Reder et al.'s suggestions and worked to develop documentation that helped students appreciate the meaning of concepts novel to the new skill domain (in this case, the concept of telecommunications, file servers, volumes, folders, etc.), remember and compare procedures to select the most appropriate one for the task at hand, and remember the exact syntactic forms for the different procedures and how to apply them in specific situations. Specifically, I did the following:

Focused on real tasks and activities. In order to involve the student, I labeled sections of the manual with headings such as "Logging on the server," "Identifying yourself," "Opening the volume," and "Naming files." In earlier testing, I found that students were usually logged on and using the server by page 4 of the documentation. To encourage students to use the server on their own, I included notes, hints, and overviews about how learners might use the server or what to expect or do when common messages (Macintosh or Appleshare system messages) would appear.

Slashed the verbiage. The current AppleShare User's Guide (1987) is 103 pages in length. From this manual I identified only that information that students would need for using the server, and I constructed this information following a bare-bones philosophy. I did not include repetitions, previews, reviews, or practice exercises; I had no index, welcome to telecommunications, or troubleshooting sections. Each of the four major sections was organized to be brief so that students could easily move from topic to topic. The manual was six 8 & 1/2" by 11" pages in length.

Supported error recognition and error recovery. In earlier testing of the minimal manual, I inventoried the principal errors of new users. From these notes I developed specific error recovery information by way of notes, warnings, and other information that addressed these common problems. With Appleshare software, the student user must work through a series of four Macintosh windows in order to log on the system. In earlier testing I found that this succession of windows confused students; they did not know in which part of each window they were to work at any given time. While Carroll et al. would advocate not using any visuals (screen shots) so that learners might better coordinate the actual system display with the description in the manual, my testing indicated that students indeed needed elaborations in this area. Therefore, I inserted visuals with short textual elaborations in the documentation. Finally, similar to Carroll et al., I inserted clarifying statements that told users what they had just done or how the icons on the screen functioned. The third page of this documentation is included in Appendix A.

### *Design of the Cards*

In designing the set of cards, I began with the minimal manual version. Following Carroll et al.'s iterative design process, I again focused on real tasks and activities, slashed the verbiage, and supported error recognition and error recovery. I used paper clips to hold the sets of seven 8 & 1/2" by 5" cards together, and I limited the number of cards to seven because short-term memory can hold a maximum of seven goals or tasks at one time (Miller, 1956).

The cards version of the documentation differed from the minimal manual version in the following ways:

1. Each card represented only one main task or goal, and the number of goals/cards was limited to seven. In the minimal manual version, there were four major headings and thirteen minor headings.
2. Task headings stressed even more strongly real work goals. For example, "Logging on the server" was revised to read, "Getting on the file server," and "Opening the volume" was revised to read "Checking folders and files on the server."
3. While there was very little verbiage in the minimal version, there was even less in the cards version. All visuals (screen shots) of the Macintosh windows/screens were deleted. Thus, the elaborations by way of visuals and short explanations in the minimal manual version were deleted in the cards version.
4. Notes and warning statements were not used. However, goals, hints, checkpoints, and error recovery information were all highlighted in the same manner, that of being in boldface, indented, and with a check mark placed in front of the information.
5. The traditional manual structure was not followed. In Carroll et al.'s (1985) case, their subjects preferred a structured manual. The cards version in this study did not look or feel like a structured manual. The cards were printed on card stock paper and held together by paper clips. All seven headings were in the same typeface and point size. The cards were not numbered but were rather collated in an intuitive order; that is, earlier tasks were placed earlier in the set (e.g., getting on the server, and checking files on the server), and later tasks were placed later in the set (e.g., putting your file on the server, and getting off the server). One of the cards is included in Appendix B.

### *Procedures*

Four weeks prior to the study, instructors introduced students to the mechanics of using the Macintosh computer and to the software that would be used throughout the quarter (MacWrite, MacPaint, and Courseware for Collaborative Writing software). Also prior to the study, the instructors met three times with me to learn how to use the Appleshare system, to send messages to all of their students' folders on the file server, and to develop a set of tasks/goals that they wanted their students to accomplish when using the system.

On the day of the study, instructors told students that they would be learning how to use the Appleshare system in order to send and receive feedback electronically with their team members and to be able to collaborate without having to meet face-to-face. The file server was likened to a large file cabinet in which students could keep their personal papers/files/folders or in which they could send messages to their instructor or group members. Students were then told that they would be receiving a checklist from their instructor that listed the tasks that they should work to accomplish during the class period.

Students were randomly assigned to one of the two versions of the documentation: the minimal manual version or the cards version. After the five-minute introduction to the study, students were given their individual passwords and were asked to begin. Students had approximately 40 minutes to use the Appleshare system after which they were each asked to complete a questionnaire about their ease in using the system.

As a follow-up measure, two and three weeks after the study, the file server was checked in order to record how much each student was using the network as a means to communicate with his or her instructor and other group members, or to store his or her own work in a private folder.

### *Dependent Measures*

There were three sets of dependent measures: observations of students' computing behaviors, students' responses to the questionnaire, and the follow-up measure, that of the students' use of the network two and three weeks after the study.

In Carroll et al.'s (1987-88) most recent set of studies, they had independent observers record subjects' ease in completing tasks, the time it took to complete tasks, the number and type of tasks completed, and the number and type of errors that subjects made. For this study, as a measure of the students' ease in using the documentation and the system, three trained independent observers recorded the students' computing behaviors. All observers previously had acted as administrators of Appleshare network systems and were extremely familiar with what should be on a computer screen at any given point in the documentation. Specifically, the observers recorded the following:

1. Time spent on each of the six tasks,
2. Number of questions asked (simple tally),
3. Number and type of errors made (these categories were similar to those used by Carroll et al. (1987-88) and included mechanical, manual, window, typing, and miscellaneous errors),
4. A rating as to how well each pair of students was coordinating their use of the documentation with the screen display, and
5. A rating as to how much a pair was enjoying the tasks.

As a measure of students' attitudes toward the documentation and use of the system, each student completed a questionnaire at the end of the class period. The questionnaire was modeled after the suggestions of Selfe (1986) and asked students for quantitative and qualitative data. Specifically, students were asked to respond to the following:

1. their ease in completing the six tasks,
2. their ease in coordinating their attention between the instructions and the screen,
3. their overall rating of the instructions,
4. the percentage of total time that they used the help offered by way of the instructions, the on-screen help, their partner, or their instructor and/or myself,
5. the percentage of their total errors that were attributed to mechanical, instructional, window, typing, or miscellaneous errors,
6. how these instructions compared to other computer instructions they had used in the past,
7. how much they intended on using this system to communicate with their instructor, to collaborate with their group members, and to store their own work in their private folders on the system, and
8. any further comments about the documentation and the system.

As a measure of how much students used the telecommunication system following the study, volume reports from the file server were taken two and three weeks after the study. These reports indicated the number of files each student had in his/her private folder.

## Results

Computing behavior results of the two treatment groups were analyzed by means of one-way analyses of variance. The means, standard deviations, *F*- and *p*-ratios are presented below in Table 1.

Table 1

| | MM | Cards | *F* (1, 36) | *p* |
|---|---|---|---|---|
| **Time on Tasks** (minutes) | | | | |
| 1. Get on server | 6.32 | 6.45 | .04 | .83 |
| 2. Check folders/files | 2.16 | 2.58 | 1.62 | .21 |
| 3. Read a file | 4.95 | 4.30 | .97 | .33 |
| 4. Transfer file from server to disk | 6.00 | 6.22 | .06 | .81 |
| 5. Transfer file from disk to server | 8.63 | 9.90 | 1.03 | .31 |
| 6. Get off the server | 3.79 | 4.57 | .63 | .43 |
| **Questions asked** | 3.95 | 4.10 | .09 | .77 |
| **Errors made** | | | | |
| Mechanical | .95 | 1.50 | 3.07 | .08 |
| Manual | 1.05 | 1.10 | .02 | .89 |
| Window | 1.63 | 2.05 | 1.42 | .24 |
| Typing | .26 | .77 | 10.12 | .002 |
| Misc. | 0 | .17 | 7.85 | .006 |

| | | | | |
|---|---|---|---|---|
| **Manual/display coordination** | | | | |
| 1. no coordination | | | | |
| 2. slight coordination | | | | |
| 3. effort at coordination | 2.92 | 3.33 | 4.06 | .05* |
| 4. clear coordination | | | | |
| 5. skillful coordination | | | | |
| **Enjoyment of tasks** | | | | |
| 1. frustrated | | | | |
| 2. semi-frustrated | | | | |
| 3. somewhat enjoying | 3.08 | 3.10 | .03 | .95 |
| 4. enjoying the tasks | | | | |
| 5. stimulated by the tasks | | | | |

The two groups did not differ in the amount of time spent on the six tasks. In fact, time spent on each task was incredibly close across the six tasks in the two treatments. Likewise, students in both treatment groups asked an average of four questions per pair of students. Considering that none of the students had previously used a telecommunication system, an average of four questions was quite low. The two groups did differ significantly (alpha = .05 or higher), however, in the number of typing and miscellaneous errors. In both cases those students receiving the cards version had more errors, but the total errors in both of the categories -- typing and miscellaneous -- amounted to less than one error per pair of students.

What is especially interesting is the observers' manual/display coordination ratings of the two treatment groups. The mean rating for those students who received the minimal manual version was 2.92 while the mean rating for those students who received the cards was 3.33. This is a significant difference between the two groups, F(1,73) = 4.06, p = .05. Those students who received the cards appeared to be able to better coordinate their use of the documentation with the screen display. Finally, in terms of enjoyment, both groups seemed to somewhat enjoy the learning tasks.

Students' responses to the circled or checked questionnaire items were analyzed using Chi-Squares. The Chi-Square analyses showed five significant differences between the two groups. Those students who received the cards version responded more positively to the instruction and use of the system than did those students who received the minimal manual version. Three key questions -- that of the ease in coordinating attention between the instructions and the screen, that of comparing the instructions to other instructions used in the past, and that of using the system in the future -- all showed those students who received the cards version to respond significantly more positively. Specifically, 94% of the students receiving the cards version felt that it was easy to coordinate their attention between the instructions and the screen, while 79% of the students receiving the minimal manual version felt that it was easy to coordinate their attention in this way.

Concerning the comparison of these instructions to other instructions they had used in the past, 80% of those students who received the cards version rated these instructions as better, while 50% of those students who received the minimal manual version rated these instructions as better. Concerning how much the students saw themselves using this system to communication with their instructor the remainder of the quarter, both groups responded quite positively: 95 of those students who received the cards version indicated that they planned to use the system some or very much, and 89% of those students who received the minimal manual indicated that they planned to use the system some or very much.

Results on the remaining questionnaire items showed that a majority of students in both groups felt that getting on the server, checking folders on the server, and reading a file on the server were relatively easy or easy tasks. Both groups indicated that they spent roughl equal percentages of time solving errors by consulting th instructions (34% in the cards group vs. 32% in the MM group), on-screen help (16% cards vs. 15% MM), their partner (20% cards vs. 19% MM), or their instructor (30% cards vs. 33% MM). Both groups also indicated that they had roughly equal percentages of mechanical errors (9% vs. 6%), instructional errors (29% vs. 33%), window errors (19% vs. 23%), typing errors (12% vs. 9%), and miscellaneous errors (31% vs. 29%). And both groups also indicated that they planned to use the system to communicate with their groups and for their own work.

Perhaps because of the short amount of time (5 minutes) to respond to the questionnaire, only 10 students wrote additional comments (5 students from th cards group and 5 from the MM group). Four students i the cards group wrote positive comments, and one wrot a negative comment; two students in the MM group wrote positive comments, and three wrote negative comments. None of the students receiving the cards version expressed a desire for a more traditionally structured form of documentation.

Students' use of the network two and three weeks after the study was analyzed using a one-way analysis o variance. Two weeks following the study, those student receiving the cards version had significantly more files (3.25 vs. 1.68) in their private folders than did those students receiving the minimal manual version, F (1, 73) = 5.30, p = .02. Three weeks following the study, again those students receiving the cards version had significantly more files (3.33 vs. 1.90) in their private folders than did those students receiving the minimal manual version, F (1, 73) = 6.61, p = .02.

## Discussion

To summarize the investigation, results from the observers showed that both groups spent equal amounts of time on the six tasks, asked an equal amount of questions, made roughly the same amount of mechanical, manual, and window errors, and appeared to somewhat enjoy learning and using the system. Students in the cards group made more typing and miscellaneous errors, but students in this group also showed better manual/display coordination, a key variable when studying the usability of documentation. Results from the questionnaire indicated that while a majority of the students in both groups felt that all six tasks were relatively easy or easy to complete, students in the cards group felt more comfortable than the minimal manual group with putting a file on the server and getting off the server. Those students receiving the cards version felt significantly more positive concerning the ease of coordinating their attention between the instructions and the screen, these students rated the quality of the cards documentation significantly higher in terms of its comparison to computer instructions they had used in the past, and they felt significantly more positive toward their later use of the system to communicate with their instructor. Results from the follow-up measure substantiated the earlier results in that students who had received the cards version used the system more that did those students who had received the minimal manual version of the documentation.

Students in this study, as all users of documentation, read something in their documentation, saw something on the computer display, and tried to connect, integrate, and interpret the two forms. I want to emphasize that, in this experiment, nearly all students (74 out of 80) in the study were able to complete the six tasks; thus, both forms of documentation helped students complete the tasks. Additionally, students appreciated both forms of documentation; the differences came in the degree of their positive evaluation. From this I can say that both forms of documentation -- the minimal manual and the cards -- are viable forms for the design and development of CBI documentation. Both forms center on the learner; both forms seek to delete extraneous text.

In terms of the observers' results, the questionnaire, and the follow-up measure, there were differences in how the students connected, integrated, and interpreted the two forms of documentation. As I discuss the differences found in this experiment, I will repeat points noted in the introduction in terms of specific learner/user problems.

First, all students involved in this study had learned how to use the computer for word processing and CAI use; however, they had not used a computer for telecommunications, and, therefore, could easily be overwhelmed by the learning task. Perhaps the clarity of the cards, with one main goal/task per card made the learning task easier and the documentation easier to follow. The clarity of these headings might also have helped students immediately to identify what they were to do or learn. These students could fan out the cards, see a direct parallel between their instructor's tasks and the cards' headings, and proceed. Students using the minimal manual, while using an incredibly minimal version compared to the original User's Guide, still had to skim through 17 headings and subheadings and determine what was most relevant.

Second, with the cards, all information could be directly executed on the screen. Students, therefore, were less apt to skip a step or trust their intuition. The minimal manual version contained more conceptual elaborations as to the definitions of a server, volume, file, folder, etc., that, while this information elaborated on what the students were actually doing, could not be directly executed on the screen. Likewise, some of the 13 subheadings, while often supplying helpful information (e.g., "naming files" ), was also information that was not directly executed on the screen.

Third, because the cards version did not contain visuals (screen shots) of the computer displays, students perhaps were more attentive to coordinating the steps with what appeared on the screen. They were forced to check visually whether a step worked before proceeding on to the next step in the documentation. Even though instructors, administrators, and students in earlier testing had requested such elaborations, in this experiment these visuals did not appear to significantly help the students.

Fourth, in the cards version, all goals, hints, checkpoints, and error recovery information were highlighted in the same manner, that of being in boldface, indented, and with a check mark placed in front of the information. Perhaps this consistency helped students clarify what they were doing and recover from common errors.

This study reinforces the fact that learning is inescapably directed by the learner. The documentation design process followed for this study centered on the learner. Perhaps because the cards version was developed after the minimal manual version, as designers we had even more time to watch learners struggle with the concept and process of telecommunicating. Perhaps because we decided to, as Carroll et al. advocate, slash instead of add information to clarify and control the dissemination of information, our cards version ended up being the absolute minimum form that this instruction could have taken.

This study also reinforces the fact that in order for learning to take place, it must relate to the goals and methods of the understander, and as such it should be based on functions rather than on a single analysis of features (Schank, Collins, & Hunter, 1986). When we design documentation, we must center on functions rather than concepts, we must think in terms of tasks rather than terms, and we must develop syntactic rather than conceptual elaborations.

Janice Redish, from the Document Design Center in Washington, D.C., invites us to think about computer tutorials as "reading to learn to do" materials. In essence, we are designing documentation that our students use in order to learn to do a task. Redish states that "tutorials work best when users are invited to act rather than to read, when users are involved as active learners, when the tutorial focuses on tasks that are relevant to users" (1988, p. 232). We have learned a great deal about how to design and develop CBI that promotes active learning; our design and development of CBI documentation needs the same degree of learner-emphasis. In designing documentation, we must concentrate on identifying the small set of basic procedures that our learners can apply to a variety of user-relevant tasks.

To conclude, I will quote one of the written comments from a student who received the cards version of the documentation:

"This is great! All instructors in all departments should have this capability! You could explain or ask a question of a chemistry instructor on another campus or after office hours. The instructor could also put your test grades in your own personal file (private) and leave you words of encouragement or otherwise. He/she could also add things such as mistakes in the syllabus, change test dates, etc. Of course, there must be a reason why they haven't done this yet."

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Appendix A. One Page from the Minimal Manual Version

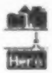
**Selecting a volume**

4. Click on "Hero" -- the volume you want to use, and then click OK.

   -- **WARNING -- DO NOT** click in the box to the right of the volume.

5. Note the "Hero" icon (shown on the next page). This is the name of the volume used in this class.

**This icon functions just as if you inserted a disk with that name into a disk drive at your computer.**

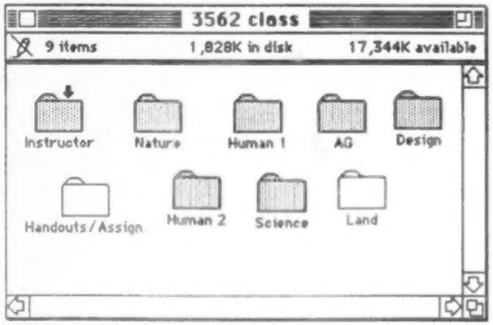


Congratulations! You are now logged on the server!

## USING THE SERVER

**Opening the Volume**

1. Double click on the volume icon labeled "Hero".
2. Double click on the folder labeled "3562 Class".
   Your screen should look similar to that shown below.



3. Note that the folder icons have three different configurations.
   If the folder is --
   - **grey**, you cannot open the folder.
   - **grey, with an arrow pointing to it**, you can drop off files into this folder, but you cannot open and see the contents of the folder.
   - **white**, you can open this folder and may be able to drop off files and drag files to your own disk.

---

Appendix B. One Card from the Cards Version

## Getting On the File Server

1 **To use the server, insert your System disk in the lower** (or internal) **disk drive.**

2 **Pull down the Apple menu and select Chooser.** In the Chooser dialogue box, make sure AppleTalk **is set to Active (lower corner of box).**

3 **Click the AppleTalk Zone named Rhetoric** (lower left corner).

4 Click the **AppleShare** icon (upper left corner). Click on **Rhetoric** which appeared in the upper right box.

5 Click **OK.** In the new dialogue box, click on **Registered User**, then type your user name. Press the tab key, and then type your password.

√ **If you used the return key instead of the tab, click on the password box and retype your password.**

√ **If you are told your password is invalid, then retype it, taking care to observe upper and lower case letters.**

6 Click **OK.** In the new dialogue box, click on **Hero**--the volume you want to use-- and then click OK. You are now logged on the server.

# Creating "Tutors" instead of "Tutorials"

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## Abstract

Although much has been written about the desirability of creating computer-based media which could simulate an intelligent tutor, relatively few programs even approximate the characteristics of a human teacher. The techniques and characteristics of good human tutors are reviewed and discussed in terms of their applicability to computer-based tutorial design.

## What is an "intelligent" tutorial?

Too many CBT and interactive video programs have been criticized for being "electronic page-turners", or for delivering essentially linear presentations occasionally interspersed with questions. Few programs make good interactive media's promise of being intelligent, conversational tutoring systems. If, in fact, the goal is for interactive systems to become " intelligent tutors" (Millward, 1979), "surrogate teachers" (Cohen, 1984) or "coaches" (Henderson, 1986) with the capability of fluently interacting with learners, it is appropriate to re-think the task of developing interactive instruction.

Although there has been a decade of interest in developing tools and models for the creation of intelligent computer-assisted instruction (ICAI), or intelligent tutoring systems (ITS), (see, for example Gentner, 1979; Sleeman & Brown, 1982) these paradigms are extremely difficult to execute, and examples are still rare. Moreover, there is little or no research to demonstrate that ICAI is instructionally more effective than traditional tutorials, and the latter are much easier and more efficient to create (Merrill, 1988). In fact, standard authoring languages and systems can cleverly be used to create tutorials which closely approximate the natural language processing and mixed initiative dialogue which characterize ICAI. It is not the authoring tool nor the hardware platform which creates an "intelligent" system; it is rather the humanistic design of the tutorial.

Ragan (1986) asserts that a "computer is more like a person than it is like other machines with regard to its instructional medium attributes" (p.1) and suggests that we use insights from the study of teaching for developing intelligent interactive media. Dede (1986), in reviewing the research in intelligent computer-assisted instruction, found that the most important characteristics of an *intelligent* system are those that model the attributes of "intelligent tutors and coaches" such as "generic teaching knowledge" (p. 349). Unfortunately, as Gage (1978) and Shavelson and Stern (1981) have found, few studies have empirically examined the practice of teaching. Ragan (1986) points out that the study of teaching is considerably separate from the study of instructional design, and that although there is a paucity of research on the nature of teacher interaction, questioning, and feedback, analyses of the behaviors of highly skilled teachers can provide assistance in formulating design principles for computer-based tutorials.

What do "live" teachers do? Ragan (1987) says that they conduct initial assessment of where learners are in their learning, continually check student progress which modifies what will be done next, make decisions about how much to attempt to convey to a particular student at particular times, decide in what order to present material to be learned, decide when to back off and when to command attention, and provide advise and counsel to students on how they are doing and what they need next. Such a description is similar to an interactive media lesson in which the program presents a pretest, continues to generate questions which determine program flow and feedback, allows some flexibility in terms of student control, and provides overall assessment of the learner's progress and advice about how to continue to interact successfully with the instruction. But what makes an *expert* teacher? Typical questionnaires soliciting student and peer evaluation of professors include items relating to mastery of the content, ability to respond clearly, directly, and pleasantly to student questions, fairness in assessments, overall "personality", ability to challenge and inspire students, and control of the classroom. Brandt (1986) in an interview with David Berliner, a noted researcher in teaching effectiveness, notes that teacher behaviors and skills related to student achievement include pacing, structure, monitoring, feedback, and questioning. These thoughts form a foundation upon which to base a new theory of computer-based tutorial design.

### Create a "tutor" rather than a "tutorial"

Good human instructors have a personality; this dimension is often missing in interactive media. If the user is required to "converse" with the tutor, there must be "someone" with whom to interact. Computer-based instruction does not need to appear to be "faceless"; in fact, programs can be designed to explicitly indicate **who** is addressing the student, and the information can be presented in the first person. Henderson describes an interactive video program created with this strategy in mind: "The videodisc recorder *[sic]* presents a teacher/expert who provides explanations and demonstrations of the concepts and skills to be learned. The regulatory function is made explicit by the instructor, who models his own thought processes as he demonstrates procedures required for the solution of a given class of problems. Serving as the expert, the instructor provides cues, hints, and counterexamples as he moves through the program" (p. 421).

### Engage the student in a conversation (not just a quiz with feedback)

Many interactive media authors equate "interactivity" with "testing". Merrill (1985) describes the stereotypic interactive instruction paradigm: "(1) Present a page of text (which may include graphics) to the student; (2) Ask a question; (3) Provide feedback on the correctness of the student's answer; if the answer is incorrect, provide remedial material (which is sometimes omitted); and (4) Repeat this cycle" (p. 20). He reflects the disappointment of many researchers in new instructional technologies, and contends that some of these strategies are hold-overs from 1960's programmed instruction, which have been found to be boring. Human tutors, on the other hand, tend to ask questions first, to see what the student already knows, and provide instruction only when necessary. As Henderson (1986) points out, a good "coach" must be able to help the learner to identify the "bugs" in his or her performance, and so it is important to afford the learner the opportunity to make errors. Asking questions first makes computer-based instruction more efficient, since unnecessary explanations and feedback are eliminated; this technique also can heighten student performance. MacLachlan (1986) summarized the findings of a number of studies on questioning and arousing student curiosity and concluded that "researchers have reported about twice as much learning when subjects were first asked questions" (p.65). By keeping instructional time down to the minimum, student's attention and motivation is increased. In fact, Tennyson and Rothen (1977) found that excessive instruction actually resulted in performance decrements.

Good conversationalists also use general information about the individual's interests or aptitudes to tailor explanations which will be readily understood. The "computer tutor" may also explicitly engage the learner in a conversation which provides information about the individual's background, previous knowledge about the subject and/or interests. Ross and Anand (1987) found that instructional text that incorporated personalization (such as using students' names, birth dates, and names of friends) was superior to nonadaptive programs in terms of students' posttest scores in mathematics lessons, and in terms student attitudes towards the materials.

### Make your "instructor" supportive and intelligent.

Often, interactive media developers create programs that interact with users in ways in which they themselves would never behave. If one is, in fact, to create a "tutor" rather than a "tutorial", it is imperative that this electronic mentor have pleasant, intelligent characteristics. The most common example of "impolite" interactive design is branching back to an exact repetition of content when a question is answered incorrectly. Not only is this endless loop an ineffective strategy (Gayeski, 1986), but it insults and frustrates the learner because it assumes that he or she was merely not paying attention. If a well-intentioned student did not understand an explanation the first time it was presented, will one or more exact repetitions help? If this happened in a conversation or a classroom, very few people would respond with a comment like "That's not correct; look at the explanation again and pay more attention this time"; yet, this is not an uncommon approach in interactive lessons (*e.g.* Hannafin *et al*, 1986; Schaffer & Hannafin, 1986). As Cohen (1984) points out, this looping back is not remediation but merely review.

Dede (1986) summarizes recent research in intelligent CAI in the area of feedback by pointing out that "learner self-image and motivation must not be damaged. The instructional response must be at an appropriate level of detail, neither so fine-grained as to be boring nor so general that the student is uncertain of its application" (p.343). Again, to make an analogy to classroom teaching, Hosford (1984) lists as a factor associated with excellence in teaching, one's ability to contribute to students' self-concepts to show respect for others.

### Examples of Computer "Tutors"

In 1982, OmniCom Associates began the development of computer-based tutorials on instructional design for use by professional trainers as well as students in corporate communication. The first tutorial, *Interactive Instructional Design*, was programmed in SuperPILOT for the Apple II. A subsequent version was programmed in BASICA for use on MS-DOS PC's, and is now a part of the *Interactive Toolkit* (Gayeski, 1987). This tutorial applies the principles of "tutor" design, engaging the learner in a personalized dialogue throughout the presentation.

Subsequent interactive video programs have had on-screen mentors directly address the viewer. In one bank training program, a humorous " invisible magician", shot as if he were standing at the viewer's elbow, pointed out correct and incorrect procedures being carried out by bank employees. In another product knowledge program for industrial sales engineers, the trainee plays the role of a game-show contestant and gets feedback directly from the show's host.

Informal feedback throughout the six years of use of these programs has confirmed our belief that this conversational style is effective in motivating the learner; many sophisticated CAI users have labeled the program "intelligent" or like "artificial intelligence". Users of the interactive video programs frequently "talk back" audibly to their on-screen mentors throughout the program. Currently, we are conducting a study comparing a CAI program designed with "human" characteristics to one written in a more traditional tutorial style. The "tutor" version is written by an identified individual in the first person, asks the user personal questions and branches or gives explanations based on that information, and incorporates the author's own style and humor in exposition and feedback. The control version uses identical content, wording, and screen design except for the "personal" questions and references.

## Conclusions

Although computer-based instruction is much-touted, most programs have failed to exhibit the very characteristics that should define it. Certainly, formats other than tutorial (for example, simulations, games, exploratory environments) can be extremely effective; however, they tend to be most applicable to certain kinds of subject matter and are difficult to conceptualize and to program. The tutorial paradigm holds much promise as an efficient means for conveying a wide range of topics.

Shavelson and Stern (1984) write that a common "script" used by teachers during interactive teaching is "structure, solicit, respond, and react." This provides an excellent summary of the bases for the guidelines presented in this paper. If computer-based instruction is to live up to its promise of providing intelligent, personalized tutoring, researchers and practitioners should explore models for creating *tutors* rather than *tutorials*.

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# TOOLS FOR DEVELOPING
# CBI RESEARCH TREATMENTS AND
# GATHERING DATA

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## Abstract

The progress of graduate students' research in instructional courseware is frequently slowed by the need to design and develop computer-based materials which can be used to administer experimental treatments and gather data for analysis and evaluation. During the last several years three generic tools have been created which facilitate courseware development for research: (1) TEXTCAD for designing 80 column, color screens, (2) Tidbit a database system for writing, filing, sorting, and selecting multiple choice test items which can be administered as achievement tests, and (3) Factor Judger to enable judges to quickly make and record systematic paired-comparisons about the relative importance of factors and then rate the relative importance of each of those factors toward a specified goal and record their judgments on disk for later analysis. Each of these tools--developed by a single individual, undergone formative evaluation by typical users, and revised--has been made generally available to all members of the working group for productive use. Each of these tools is briefly described by the author. Other tools will be developed as time, talent, and needs are identified.

## TEXTCAD:
## Computer Aided Design of Text Screens

It was recognized that while paint programs existed for the development of graphic displays, no similar environment existed for the development of color text screens. Using programming languages to create, compare, and edit text displays was a slow and painstaking process.

TEXTCAD combines features found in paint and word processing programs to produce an environment that allows a designer to create, compare and edit color text screens. TEXTCAD generates disk files that can be accessed by many programming languages so that screens may be incorporated directly into software.

### Working Environment

Command bars, pull-down menus and dialogue boxes are used to access the commands and controls built into TEXTCAD. What you see is what you get while creating screens. Several commands are accessed through single key presses (e.g., UNDO), others are accessed by selecting them from pull-down menus. The VIEW command hides or displays the command bars so that screens may be viewed unobstructed.

### Creating, Editing and Saving Screens

Arrow keys move the cursor around the screen. Text is displayed by placing the cursor and typing the text. The BACKGROUND and FOREGROUND color commands determine the background and foreground color used when characters are placed on the display and when the PASTE (EDIT menu) and FILL commands are used. The BORDER command sets the border (overscan) color. The BLINK command turns the blinking attribute of text on and off. FILL causes a change in the background color currently displayed. SWAP is used to exchange one color for another, background or foreground, and to change the state of blinking or non-blinking text. The color commands are found in the COLOR pull-down menu.

The BLOCK SET command is used to "rope off" a portion of the screen to limit the effect of certain commands. For example, without the use of a block the FILL command would change the background color of the entire screen. By setting a block the FILL command only changes the background color of the area of the screen inside the block. Cursor movement, color swapping, erasing, cutting, copying, pasting, etc. are limited by the BLOCK SET command.

The UNDO command replaces the screen with a copy of the screen made before the last access to a command or menu. The effect is the erasure of mistakes.

The EDIT menu commands are used in conjunction with the BLOCK SET command. ERASE clears all characters from a block. CUT places a copy of a block in a buffer for pasting purposes then erases the block. COPY performs the same function as CUT, but the block is not erased. PASTE places the contents of a buffer filled by CUT and COPY on the screen at a position specified by the cursor. There are three forms of PASTE that differ on the basis of colors used in the pasting process.

Ten screens may be stored in the TEXTCAD environment at any time. Switching between screens is accomplished using the PAGE command.

The ALT CHAR SET command allows the user to choose from one of four line drawing character sets and allows for the redefinition of the number keys when the keyboard is in the ALT CHAR SET mode. The ESC key toggles the ALT CHAR SET mode on and off. With the mode on, the cursor keys are used to draw lines and the number keys are used to place any of the displayable ASCII characters. In addition a section of the keyboard contains the pieces of the current line drawing character set. NEW resets the TEXTCAD environment and erases all screen designs. DOS SHELL allows the user to execute DOS commands. QUIT quits TEXTCAD.

The FILE menu presents a set of commands to save and load screen designs to and from disk. LOAD and SAVE allow the user to load and save individual text screens or groups of text screens called PROJECTS. PATH allows a DOS path to be set.

The INS key is used to insert spaces on a line. DEL and BACKSPACE are used to remove spaces and characters from a line and CTRL I turns the insert mode on and off.

## Visual Comparison of Screens

MANUAL and TIMED are commands used to display a sequence of screens in an order set through the use of the ORDER command. In the MANUAL show mode, movement to the next or previous screen takes place when the user presses the right arrow key or left arrow key respectively. In the TIMED show mode the change to the next screen in the sequence takes place after an interval of time set by INTERVAL has passed. The ORDER command prompts the user for the screen sequence.

Similar screen designs can be compared by showing the screens in sequence. With the ability to quickly switch between any two screens small differences become evident. Screen sequences can also be displayed to view their effect. A built-in note-taking facility allows the designer to take notes about the screens.

## Importing Screens Into Software

Screens created and saved by TEXTCAD can be used in a piece of software. The author has successfully used TEXTCAD screens in PC Pilot and C programs. For the purpose of using TEXTCAD screens in PILOT programs, a special utility was written to convert TEXTCAD files to a format that will allow a programmer to use the Pilot GX: command to load the screen. All the code that is needed to load a converted TEXTCAD screen called TITLE using Pilot is GX:TITLE.

## Help

The pull down menus provide the user with context sensitive help. Access to all of the help files is available while in the edit mode. TETXCAD allows the user to add comments and notes to the help files allowing the user to customize the help.

## Field Testing

TEXTCAD was field tested by graduate students taking a course in the development of educational computer simulations during the winter quarter of 1989. The students used TEXTCAD to design text screens which they imported into the simulation programs they wrote in PC PILOT. Feedback about TEXTCAD operation and usefulness was received verbally and through the use of the TEXTCAD on-line, note-taking facility. Comments made by the students were used to update TEXTCAD.

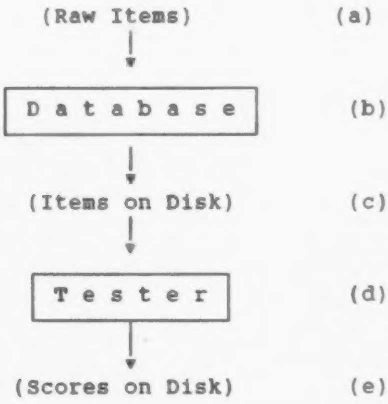
Comments conveyed how TEXTCAD had changed creating screens from a programming task to a visually oriented design task. One student said, "This feels more like painting and drawing than programming." Creativity was evident in the screens designed by the students. Splashes of color, complex designs, shadowed menus, and non-keyboard ASCII characters permeated their creations. Several students, while using TEXTCAD, described it's use as fun! Another student while learning how to use TEXTCAD exclaimed, "This is wonderful!"

TEXTCAD was designed and developed by and is the property of Dale R. Musser.

## Tidbit

Tidbit is a computer software package designed to simulate and extend the methods and standards of traditional paper and pencil tests. The package is made up of two distinct, separate components: a test item database system and an on-line test administrator. The two software components work in tandem to allow an individual to assemble, edit, store, administer and score multiple-choice test items and tests.

Below, the overall relationship between the two pieces is illustrated in a simplified flowchart.



The database system (b) serves as a storage device for test items, which may come from a variety of "raw " sources (a): old written tests, textbooks, etc. Once stored in a database file, specific items may then be selected and exported to a text file on a separate disk (c). The tester (d) is then used with the text file to administer the test--to one or a number of testees--and the resultant score (e) is written to a new text files on a testee's diskette.

## The Database System

The database side of Tidbit is a stand alone software system for collecting multiple choice test items. Foxbase+, a dBase III+ clone, was used in its initial development, with Clipper used to compile the final version to a single program file.
The system allows for the use of an unlimited number of database files and each file may contain up to one billion items. In addition, a user may specify file names and target disk drives, and so create their own conventions for organization.

The entire system is menu driven. From the main menu a user may choose to open a file; add, edit, view or print items; generate a test text file; or create a new file. When viewing items, a user moves through the database using page up and down keys. At any time the user may open the current test item for editing or filter the entire file to view only items containing specific key words.

Each test item has three sections: question, possible responses, and code. A question is made up of five lines, 60 characters in width. For possible responses five lines are assigned, one for each response, also having a width of 60 characters. In addition, each response has a corresponding one character field for attributing an asterisk to the correct response. The code area allows a user to assign unique character codes to a series of test items for easing later access to specific groups of items.

Questions and responses will appear in the final test just as they are typed in the database file, with a few important exceptions. First, blank lines will be suppressed when presented to the testee. Second, the order of the responses will be shuffled for individual testees. Third, PC Pilot program codes for text manipulation may be integrated into the questions and responses. If done properly, text may be highlighted and colored at the user's discretion.

Generating a test text file requires that a user name the test and specify whether the test should be self-loading or that a testee should key in the test name. The resulting text and test configuration files are then copied to individual diskettes along with the Tidbit tester for test administration.

## The Tester

Using the Tidbit test administrator, the database generated text file is presented to testees as a computer based test. The test administrator was developed using PC Pilot and, when in final version, encrypted to be used in conjunction with PC Pilot's distributable program file.

The tester prompts the testee for their name and, if specified in the configuration file, the name of the test. A testee may then either access a brief frame lesson on how to use the tester or proceed to the test.

The order of the test items and possible responses within each item are randomized each time the test is taken. However, a testee may pass through the test as many times a they like without exiting and saving their score to disk, and the initial order of items will be maintained.

Questions and possible responses are presented to the testee along with the question number as it appears in the randomized sequence and prompts for how a testee may proceed. Responses are labeled "a" through "e" depending on how many there are and testees may answer an item by simply pressing the character corresponding to their choice. Once a choice is made it is highlighted with an arrow and will appear so each time it is viewed or until a testee revises their choice. Testees may also skip an item without answering, jump randomly around the test, go backwards through the test one item at a time, access the help screen, access a small word processor for commenting on a specific item, or exit the test.

Once the test is exited, the items are scored against the correct responses, the original order of the items is restored, and the scores and comments are recorded to disk in a text file bearing the name of the testee. The testee may then review items they missed and make additional comments.

The text files containing the scores may be imported into virtually any word processor. Included in the format of the file are the testee's full name, the original record numbers as the appear in the database for all the items, and the comments created with the tester's word processor.

Tidbit was designed and developed by and is the property of G. Mitchell Lear.

## FJ: Factor Judger

Within a complex problem-solving environment, judging the relative importance of each factor to every other factor in the environment (paired comparisons) and rating the extent to which each factor contributes to the problem solution has long been a powerful technique for causing individuals to make very fine discriminations. However, the sheer amount of work in making the comparisons and ratings dissuades regular application of the technique.

Creating computer-based, instructional simulations is facilitated by making such discriminations. For example, what is the relative importance of each of the educational and administrative factors which influence the effective use of computers in an educational setting? How important is the distribution of financial resources among expenditures for hardware, software, and teacher training? Where should computers be placed for maximum effectiveness--computer laboratory, media center, individual classrooms? Discussing the factors among members of a development team can lead to heated debate, but having team members individually compare the importance of all factors and rate the extent to which each factors contributes to the problem solution creates a surprising level of congruence in their judgments.

Factor Judger was designed and written in PILOT to manage and present factors to individual judges, gather and record data from their judgments, and print that data for later use.

## Procedures

Evaluation of potential problem solutions requires three steps: (1) set-up in which the list of factors to be used in evaluating each solution is created in the system, (2) weighting each factor for importance, and (3) rating the extent to which each factor contributes to the problem solution.

### Set-up

The range of factors influencing a problem solution can be multi-dimensional resulting in nonsense judgments if all were to be compared. Factor Judger allows factors to be categorized and compared with other factors within the sub-category and then for the higher-order categories to be compared for importance. For example, judging the importance of using computers at the first grade level with the importance of word processing does not make sense, but comparing first grade use with fifth grade use (sub-categories of a grade level factor) and comparing word processing with tutorial instruction (sub-categories of an application factor) does produce useful comparisons. Factor Judger allows for creating categories with sub-categories simply by entering the names with a word processor. The variables for displaying the factors and for storing judgments are built-in, and their use is automatic and transparent to both the researcher setting up the program and to the user who is making the judgments.

Set-up also requires that the overall goal be defined so that it can be displayed to the judges at all times. For instance, in the example above, "To use computers to achieve maximum educational benefit in grades K-12" would be presented on the screen at all times while users were judging the relative importance of each factor and while they were rating the contribution of each factor to the problem solution.

### Weighting the Factors

With the overall goal displayed on the screen, the judge would be presented with each factor paired individually with each of the other factors and asked the question:

**"Which factor is more important? A or B"**
**A Resources for hardware**
**B Resources for teacher training**

followed by the question:

**"How much more important?"**
**1 = slightly more**
**2 = moderately more**
**3 = much more**

then the question:

**"Which factor is more important? A or B"**
**A Resources for hardware**
**B Resources for software**

followed by the question:

**"How much more important?"**
**1 = slightly more**
**2 = moderately more**
**3 = much more**

then the question:

**"Which factor is more important? A or B"**

**A Resources for teacher training**
**B Resources for software**

followed by the question:

**"How much more important?"**
**1 = slightly more**
**2 = moderately more**
**3 = much more**

The weight (1, 2, or 3) earned by each factor as it is compared individually with each of the other factors is then summed to create a total weight for that factor.

### Rating the Factors

After assigning a weight to each factor, the next task is to rate the contribution of each factor to the overall goal. With the overall goal displayed on the screen, the judge is presented with each factor individually and asked the question:

**"To what extent does this factor fulfill the goal?"**

5 = **Completely fulfills the goal**
4 = **Fulfills at least 75%** of the goal
3 = **Fulfills at least 50%** of the goal
2 = **Fulfills at least 25%** of the goal
1 = **Fulfills less than 25%** of the goal
0 = **Does not meet the goal** at all
X = **Factor does not apply**

The rate is then multiplied by the weight for each factor to create a weighted rating for the judged relevance of each factor toward the goal.

### Outcomes

The records generated by each judge are saved on disk in a file identified with the judge's name. The file contains the name of each category of factors followed by the factors within that category along with the summed weight of that factor, the rating of the factor, and the weighted rating (rate x weight) assigned by that judge.

## Applications

Asking judges or subjects in an experimental treatment to make paired comparisons, to rate the importance of the differences, and then to judge the overall importance of those factors to larger problems can provide valuable insights into personally held opinions and perhaps even attitudes. We have used FJ to gather judgments and data to assign relative power and influence in the decision algorithm within an instructional simulation. Many other applications are also possible.

Factor Judger was designed and developed by and is the property of Keith A. Hall.

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# PLANNING AND DEVELOPING AN INTELLIGENT INFORMATION INTEGRATION AND MANAGEMENT SYSTEM

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## ABSTRACT

Three separate information systems on steel structures have been developed at the Technical Information Center for Steel Structures (TICSS) at Lehigh University's ATLSS Engineering Research Center and are now undergoing beta testing: 1) bibliographic data base; 2) current research; and 3) software on steel structures. Several other systems are planned.

This paper describes the planned application of expert systems technology to the development of the TICSS intelligent integration/management system which will support the formulation of queries for needed information, then provide access to the appropriate information system or to other external information sources such as on-line or CD-ROM data bases. It will also provide a uniform and supportive interface for human users of the system and for other ATLSS expert systems. The TICSS intelligent information system provides a potential solution to the information overload faced by engineering professionals.

Issues discussed include: selection of hardware and software environments; lessons learned from beta testing of prototypes of the three information systems; the decision to extend the range of technologies involved to include using combinations of expert systems and hypermedia to identify, locate, obtain, and utilize relevant technical information; and the evolution of TICSS into the Combined Advanced Information Technology Systems (CAITS) Project.

## INTRODUCTION

The Technical Information Center for Steel Structures (TICSS) is a part of the National Science Foundation-funded Energy Research Center for Advanced Technology of Large Structural Systems (ATLSS) at Lehigh University. The goal of the Technical Information Center for Steel Structures is to identify and make available for use the knowledge pertinent to all aspects of steel structures. These materials include textual, graphical, and visual material such as bibliographical material, technical data, case studies, project reports, and slides and photographs. Emphasis is placed on providing access to information, such as technical reports, which is not available through other information sources such at the National Technical Information Service (NTIS).

The program is designed for use by practicing engineers and engineering researchers who are not necessarily computer specialists. In addition, the information systems developed by TICSS are designed to be interfaced with expert systems and other computer systems being developed by other ATLSS projects.

### Information Systems Developed to Date

To date three separate information systems have been developed and are now undergoing beta testing. These systems include a bibliographic data base on steel structures, a data base of current research on steel structures, and a data base of software related to steel structures.

TICSS System One is a computer-manipulable information base of bibliographic and other reference information on steel structures. Materials for the information base have been obtained from existing hard copy and machine-readable sources currently in the library of Lehigh's Fritz Engineering Laboratory, from the Structural Stability Research Council, from other sources at Lehigh University, and from the American Institute for Steel Construction (AISC).

The bibliographic system is designed in such a way that it could become part of a comprehensive knowledge-based system. The system also is designed for later conversion to optical-disc storage media (CD/ROM, CD-I, or other formats as they become available).

The TICSS bibliographic data base is designed to accomodate information on fifteen different types of documents with a total of 35 fields. The system uses screen templates to guide data entry, and is designed to be very flexible. Full-text editing capabilities are provided (insertions, deletions, arrow keys to move from field to field on same screen, etc.). When the user indicates the information on the screen is correct, that information is written to disk.

In search/retrieval mode, the user utilizes an on-screen template to specify a search strategy. Boolean combinations of up to two authors, two words in a document title, and three identifiers (year of publication, organization, sponsor, or other relevant information) can be specified. The total number of documents matching the search criteria is automatically updated and displayed. A wide variety of screen display and hard copy options are available.

System One has been developed in Turbo Prolog, in order to facilitate the planned expansion of its capabilities to include a knowledge base of rules for searching and using information.

TICSS System Two is a computer-manipulable information base of computer software relevant to design and construction of steel structures. Software included deals with complete structures (for example, buildings and bridges) as well as structural components (for example, beams, columns, or connections). The program allows the user to search on specific topics to identify appropriate software.

The system is completely menu driven and makes extensive use of on-screen templates to guide the user. The opening menu presents options to 1) Add Information, 2) Browse Information, or 3) Search Information, or 4) Produce Reports. A variety of powerful search options and report formats are available.

System Two is developed in dBASE III Plus (Ashton Tate, 1986). The final version of the prototype will be distributed in compiled form.

TICSS System Three is a data base for current research on steel structures. System Three provides a useful and effective tool for engineers, engineering researchers, and engineering students. The main objectives of this subsystem are (1) to provide access to information on specific current investigations on steel structures; and (2) to provide the information necessary to contact specific investigators. The subsystem provides the users with information on the type of investigation, the investigators, sponsors, addresses, a brief abstract, and additional relevant information. The information supplied by this subsystem will prevent duplication of investigators' efforts and make possible more efficient communications between researchers and consumers of research.

System Three was developed in dBASE III Plus, and is similar in form and features to System Two.

Additional systems under development or planned include a system containing visual information to be converted to computer-useable form from 35 mm slides, and a system of current research needs.

## Lessons Learned from Field Testing

Initial field testing of the separate TICSS systems prototypes indicated that potential users experienced some difficulty in determining which of the separate systems might be useful for their immediate problem. Often during the same interaction session users found that they needed access to information which was included in several separate TICSS systems. Currently, the user must manually terminate the use of one system and activate another system in order to use the second system.

Field testing and prior experience also indicated that the potential users of the TICSS systems were not well skilled in utilizing information bases. The effective formulation of search queries, particularly compound queries using Boolean combinations of search specifications, proved difficult to many users of the prototype. It was decided that a different approach to the question of the user interface was needed, one that did not rely on learning traditional database concepts and skills.

Several additional needs were identified through experience with the prototype systems. First, it was recognized that not all relevant information for a particular user could be incorporated into the TICSS systems. In particular, no attempt was planned to duplicate the holdings or services of large data bases such as Engineering Index or the National Technical Information Service, which are available both on-line and on CD-ROM. It was felt, however, that the TICSS system should attempt to provide access to these external information services when the user's queries indicate that the information needed can be obtained from them.

A second and related need was that the information relevant to a particular engineering problem included in most cases information in forms other than text or numerical tables. This additional information often was in the form of computer-generated graphics, photographs or slides, blueprints or other engineering drawings, or other types of visual information. Users often needed multimedia information to solve their problems, and they usually needed simultaneous access to materials in a variety of formats. It became obvious that, in order to be useful, TICSS information systems had to be integrated multimedia systems.

A third additional need was that users of other expert systems developed by ATLSS, such as the Bridge-Fatigue Investigator and the Designer/Fabricator Interface, would at times need access to relevant technical information while using those systems. An additional goal of the TICSS project, then, was to provide a supportive interface to other ATLSS expert systems.

## The Solution: Combined Technology Systems

Review of the results of field testing indicated that the major information needs of the ATLSS Engineering Research Center could be met through: 1) integration and coordinated, computer-based management of the separate TICSS systems; 2) a system which could manage information in a wide variety of multimedia formats; 3) a useful and supportive interface to both human users and other ATLSS computer-based systems. In order to meet these needs, the goals of the TICSS project were expanded to include integrating and managing information systems using combinations of expert systems technology and hypermedia technology.

Hypermedia is an extension of the concept of hypertext, a term first coined by Ted Nelson (1967) to denote nonsequential writing and reading. Nicole Yankelovich defines hypermedia (Yankelovich, Meyrowitz, and van Dam, 1985) in these terms: "We use the word **hypermedia** to denote the functionality of hypertext but with additional components such as two- and three-dimensional structured graphics, paint graphics, spreadsheets, video, sound, and animation. With hypermedia, an author can create links to complex diagrams, texts, photographs, video disks, audio recording and the like."

Because of the extension of its goals, it was determined that the Technical Information Center for Steel Structures (TICSS) should be incorporated into a new project to be named Combined Advanced Information Technology Systems (CAITS). The goals of TICSS, as they have evolved over the last three years, will be incorporated into the overall goals of the CAITS project. In addition, the CAITS project will have additional goals related to the applications of hypermedia and expert systems in a wider range of ATLSS activities, including training and dissemination activities. The Combined Advanced Information Technology Systems project (CAITS) will carry out basic research on how two advanced technologies -- knowledge-based systems and hypermedia (interactive multimedia). The objective of CAITS is to apply combinations of these two technologies to help engineering professionals, engineering researchers, and engineering students identify, locate, obtain, and utilize relevant information in a many different formats.

## Potential Hypermedia Applications for Engineering

The specific goals to be achieved during the next three years will be developed during the 1989-90 academic year in cooperation with the ATLSS administration and thrust/cluster leaders.

The following list is indicative of some of the ways in which hypermedia may be applied within ATLSS and within the engineering industry.

## Potential Applications of Hypermedia within ATLSS

1. Building on the information base embodied in the three information systems developed by the TICSS project, hypermedia technology can be applied to restructuring that information and providing enhanced mechanisms for users to identify, access, and utilize that information. As the TICSS information base grows, the additional information could be incorporated into hypermedia systems as they are developed.
2. The information system based on slides of large structural systems which TICSS is now planning and projected future visual information systems could be developed in a hypermedia environment rather than as traditional database systems.
3. An area of increased research interest in information technology is the issue of visualization of data. The ATLSS testing facility and other ATLSS projects will continue to produce large amounts of data on large structural systems. Hypermedia offers potential new and better ways of presenting these data and promoting their understanding.
4. Hypermedia tools exist for utilizing optical disc storage for both applications software and large volumes of data. Using or adapting these tools would greatly facilitate the development and capabilities of new information systems.
5. Hypermedia and/or hypermedia techniques could be used to develop better user interfaces for existing projects (e.g., the Bridge Fatigue Investigator or the Designer/Fabricator Interface). In projects now beginning, hypermedia concepts could be incorporated into the initial planning, and their application could be developed simultaneously with the development of the rest of the project. Hypermedia could also be applied to ATLSS computer-controlled testing activities.
6. As projects reach maturity and the products they develop are prepared for dissemination, the need for training materials and other dissemination materials will increase. Hypermedia provides a powerful and effective training medium for these finished products.

In summary, the CAITS project has as its general goals the integration and management of information relevant to large structural systems by utilizing combinations of hypermedia and knowledge-based systems technologies. CAITS systems will provide a bridge from human users and computer applications developed by other ATLSS projects to both TICSS information systems and information systems from other sources, as well as supporting training on ATLSS systems and dissemination of knowledge generated by ATLSS. Figure 1 presents an overview of the Combined Advanced Information Technology Systems project and its interaction with others.

## Initial Plans for the CAITS Project

Initial planning for the first year of the CAITS project is now being carried out. Initial activities include a general review of current practices related to the uses of expert systems and hypermedia for information management in engineering and evaluation of suitable hardware and software platforms One hardware and software environment has already been selected for prototype development. For Macintosh II microcomputer workstations, we are using HyperCard (Apple Computer) and SuperCard (Silicon Beach Software) hypermedia packages, and the Nexpert Object expert system development package (Neuron Data, 1987). Nexpert Object was selected because it supports object-oriented expert system paradigms which were identified as appropriate for the task of developing the intelligent system envisioned, and because it can readily be linked to hypermedia applications developed using HyperCard (Apple Computer) and to traditional data bases using Oracle or other commercial database software.

Current plans also call for obtaining an IBM PS/2 286 or PS/2 386 workstation and for developing prototype hypermedia applications using either HyperTies, Linkway, or Audiovisual Connection (AVC),the new multimedia package to be released by IBM in early Fall, 1989.

## CONCLUSION

The TICSS intelligent information system provides a potential solution to the information overload faced by engineering professionals. Techniques used in artificial intelligence for knowledge representation and expert systems are combined with existing highly refined relational data base techniques for storing large amounts of carefully structured and organized data. A hypermedia-based user interface will allow the user to access multimedia information and to establish linkages among multimedia information which meet their own personal needs, while intelligently guiding the user in navigating through the body of information available. Thus, the computer has the potential to become an extremely useful tool for engineering professionals in their use of information in a greatly increased range of formats.

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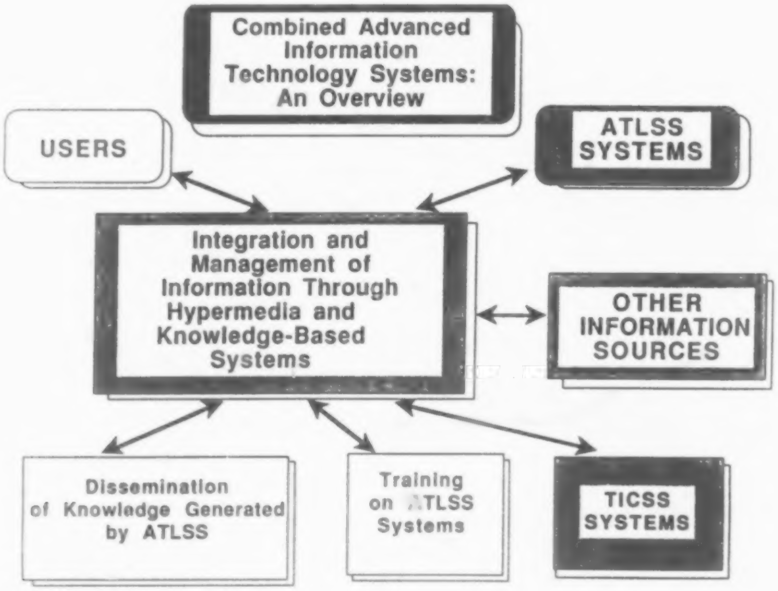
Combined Advanced Information Technology Systems: An Overview
USERS
ATLSS SYSTEMS
Integration and Management of Information Through Hypermedia and Knowledge-Based Systems
OTHER INFORMATION SOURCES
Dissemination of Knowledge Generated by ATLSS
Training on ATLSS Systems
TICSS SYSTEMS

Figure 1

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# THE EFFECTIVENESS OF THE COMBINED AND REPEATED AMONG VERBAL, SOUND, AND GRAPHIC FEEDBACKS ON STUDENTS' CAI LEARNING ATTITUDE

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## Abstract

Computers can generate various types of verbal, sound, and graphic responses to be used as KR feedbacks for students in the CAI learning process. The effectiveness of combined and repeated of feedbacks on K3 and K8 students was examined in this study. The results of this study indicated 1) The subtypes of the combination of all and sound were preferable to those of the combination of either two. 2) The degrees of K3 students' preference were decreased in proportion to the recurrence of the same feedback, while K8 students' preference in inverse ratio; in other words, K8 students' interests dwindle in face of the recurrence of the same feedback. The findings of this study could be meaningfully employed in CAI KR feedback design. (This study was sponsored by the National Science Council of the Republic of China.)

## Introduction

The effectiveness of feedback in adherence with CAI courseware has been recognized in many studies (Anandam, Eisel and Kotler, 1890; Butler and Nisan, 1986; Phillips and Berkhout, 1978). In 1981, Gagne and his collaborators listed nine strategies for instructional events. Among those nine strategies of instruction, the feedback strategy was an imperative one in designing a CAI courseware. For this reason, this study examined the effectiveness of CAI feedback design on students' learning attitude towards the repeated and combined feedbacks.

## Research Question of This Study

Nowadays, three basic types of feedbacks were most often used in the CAI learning process: verbal, graphic and sound feedbacks, which, divided into many subtypes, arouse students' different degrees of preference. Usually, students have their preference not only to the verbal, graphic and sound feedbacks combined together, but also to the recurrence of the same feedback. The purpose of this study was to explore the following question:

Did participants of this study have different degrees of preference to the different designs of feedbacks on:

1. the combination of the verbal, graphic, and sound feedbacks;
2. the recurrence of the same feedback?

## Hypotheses

The preference of the students have different degrees to the various types of feedbacks. To understand the effectiveness of feedbacks on students' learning, the null-hypotheses of this study were constructed as the following two:

Ho1: There was no significant difference in the degrees of preference to any combinations of the verbal, graphic and sound feedbacks.

Ho2: There was no significant difference in the degrees of preference to the recurrence of the verbal, graphic and sound feedbacks.

## Definition of Terms

Combined Feedbacks: The verbal, sound and graphic feedbacks may be combined together in twos or threes in different orders. The choice of the combination elements was based on the previous research which found out the preferred verbal, sound and graphic feedbacks. For example, if students' responses were correct, the preferred type of verbal feedback (You are really something) and the graphic feedback (flower blooming) were combined together on screen. Altogether there were 18 types of combination for analysis.

Repeated Feedbacks: The recurrence of the same positive feedback was given to students' correct answers and the same negative feedback to the incorrect ones.

## Survey of the Literature

The Behavorist School's theory about the stimulus-response reinforcement may well be applied to CAI. Derry and Murphy (1986) proposed the following three principles on the designing of the frequency of feedbacks.

1. In the CAI learning process, feedbacks should appear on proper occasion.
2. Feedbacks appeared in correspondence with students learning efficiency.
3. Feedbacks should be reduced in high-level students' learning process.

As to the principles about the repeated feedbacks, there were some researches available. For example, Brown and Agnew (1987) upheld that the recurrence of the same feedback would result in the participants' unwillingness to answer. Salmoni, Schnidt and Walter's (1984) research on feedback frequency and motor learning also reveals the fact that the repeated feedback would influence the participants' learning motive.

## Research Method

The sample of this study To explore the different degrees of preference to the various types of feedbacks, the ideal sample of this study should consist of students from primary to senior high school; yet, restricted by time, labor and expenditure, this study could only focus on K3 and K8 students.

### The Instruments of this study

Field experiment was employed to explore the effectiveness of feedbacks on K3 and K8 learning attitude in the CAI environment. Therefore, two kinds of stimulus materials were constructed: the combined feedback and the repeated feedback, to determint their effectiveness on students' learning. The basic concepts of these two feedbacks were as follows:

Combined feedbacks:

As sounds, graphics and verbals could appear simultaneously on a computer screen, so in the CAI environment, the three feedbacks can be combined together to influence learning effectiveness. Because the indiscriminate combinations of verbal and graphic feedbacks, being generated as text and consuming too much memory space in the computer, were unsuitable for CAI, and the co-existence of verbal, and sound or graphic and sound were preferable. The different ways of combination were listed as graph 1.

1. The whole three combined together: verbal - sound - graphic; graphic-sound - verbal; verbal / sound - graphic; sound-verbal- graphic; graphic / sound - verbal; sound-graphic-verbal; graphic-verbal-/sound; graphic - verbal - sound; verbal - graphic / sound; verbal - graphic-sound.
2. The random combination of either two: verbal/sound; sound- verbal; verbal - sound; sound - graphic; graphic - sound; graphic - verbal; verbal-graphic.

For examples:

Verbal feedbacks: if the answer was correct, the computer generates such feedbacks as "Very smart!" or "You're really something"; if incorrect, "Very stupid" or "Think it over".

Graphic feedbacks: if the answer was corrct, flower blooming or a basketball thrown into a basket would be generated; if incorrect, flower withering or a basketball thrown out of a basket would be generated.

```
                                    __|-- verbal - graphic
                                   |  |-- graphic- verbal
                  -------------    |
       ----------| combined two |  |  |-- graphic- sound
       |         |        types |--|--|-- sound  - graphic
       |          -------------    |  |-- sound  / graphic
       |                           |
       |                           |  |-- verbal - sound
       |                           ---|-- sound  - verbal
   ----------                         |-- verbal / sound
  | combined |
  | feedback |
   ----------
       |                              |-- verbal - graphic-sound
       |                              |-- verbal - graphic/sound
       |                              |-- graphic- verbal -sound
       |           -------------      |-- graphic- verbal /sound
       |__________| combined     |____|-- sound  - graphic-verbal
                  | three types  |    |-- graphic/ sound  -verbal
                   -------------      |-- sound  - verbal -graphic
                                      |-- verbal / sound  -graphic
                                      |-- graphic- sound  -verbal
                                      |-- verbal - sound  -graphic
```

Graph 1 : The Classification of Combined Feedback.

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Notes: * "-" indicates the subsequent generation of feedbacks.

* "/" indicates the simultaneous generation of feedbacks.

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Sound feedbacks: if the answer was correct, "Two Tigers" or an upward tune would be generated; if incorret, "Night in a Deserted City" or a downard tune would be generated. Moreover, in the subtypes of combined feedback, such combination as "Very smart" followed by the graphic of a flower blooming or "You are really something" followed by the graphic of a basketball thrown into a basket where used as the answer was correct. And when the answer was incorret, such combination as "Very stupid" followed by the graphic of flower withering or " Think it over " followed by the graphic of a basketball thrown out of a basket, and so on were shown on.

Repeated feedbacks:

It is assumed that the recurrence of the same feedback would reduce students' interest in learning. This study chooses seven subtypes of repeated feedbacks as the stimulus materials: 1) graphics, 2) verbals, 3) sounds, 4) graphics-verbals, 5) graphicssounds, 6) verbals-sounds, 7) graphics-sounds-verbals.

For exemples:

Verbal feedbacks: 1) "Very smart" for correct answers; "Very stupid" for incorrect answers; 2) "You are really something" for correct anwers; "Think it over" for incorrect answers.

Graphic feedbacks: 1) flower blooming for correct answers; flower withering for incorrect answers; 2) a basketball thrown into a basket for correct answers; a basketball thrown out of a basket for incorrect answers.

Sound feedbacks: 1) "Two Tigers" for correct answers; "Night in a Deserted Night" for incorrect answers; 2) an upward tune for correct answers; a downward tune for incorrect answers.

Table 1 : Repeated Feedback examples.

| 20 items | The first part | | The second part | |
|---|---|---|---|---|
| | correct | wrong | correct | wrong |
| verbals | very smart | very stupid | you were really something | think it over |
| graphics | flower blooming | flower withering | a basketball thrown into a basket | a basketball thrown out of a basket |
| sounds | two tigers | deserted night | an upward tune | a downward tune |

And the types of combined feedbacks were mentioned in the preceding part. The participants were given 40 questions; each correct answer to the first 20 questions was followed by the same feedback, and each incorrect answer was likewise followed by the same feedback. For example, the correct answers have the same verbal feedback "Very smart" and the incorrect , "Very stupid" in the first 20 questions.

Every student was given 40 questions generated from the software, and no matter whether their answers were correct or incorrect, the feedbacks would appear on the screen and students should respond on a preference scale ( 7 scales ), which was analysed by "One-Way Repeated Design ANOVA" or "Trend Analysis".

## Findings

This study was to explore the preference among K3 and K8 students to subtypes of combined feedbacks. The raw data, collected from computers simultaneously while students respond on the preference scale, goes further analysis. Briefly, the results of this study were as follows:

Overall comparison between C3 and C2

The following abbreviated C3 and C2 representing as:

C3: the combination of the whole three feedbacks: verbal, graphic and sound.

C2: the random combination of either two types of feedback.

On overall comparison betweem C3 and C2 , the samples indicated:

1. There was a significant difference in the degrees of preference among K3 and K8 students to C3 and C2 feedbacks.
2. Some of the K3 students, no matter whether their answers were correct or incorrect , preferred C3; so do the K8 students.

The prefernce to the subtypes of C2:

The combination of either two of the verbal, graphic sound feedbacks has eight forms for analysis, appearing simultaneously or subsequently. The resutls of this study could be concluded as follows:

1. The combination of graphic followed by sound was preferable to the simultaneous generation of sound and graphic.
2. The verbal followed by sound was preferable to verbal followed by graphic.
3. The simultaneous generation of verbal and sound was preferable to sound followed by verbal.

As for the other subtypes of C2, there was no preference.

Degrees of preference to C2 and C3:

A. The degrees of preference among K3 students to positive C2 and C3 feedbacks:
   1. C2 was preferable to C3:
      (a) All K3 students were more interested in the subsequent generation of verbal followed by graphic than in that of sound, graphic and verbal.

(b) Verbal followed by sound was preferable to the simultaneous generation of graphic and sound, followed by verbal.
(c) Sound followed by verbal was preferable to the simultaneous generation of graphic and sound, followed by verbal.
(d) The simultaneous generation of verbal and sound was preferable to the subsequent generation of sound, graphic and verbal.

2. C3 was preferable to C2:
   (a) The subsequent generation of graphic, verbal and sound is preferable to that of sound followed by graphic.
   (b) The simultaneous generation of verbal and sound followed by sound was preferable to the subsequent generation of verbal and graphic.
   (c) The subsequent generation of verbal, sound and graphic is preferable to that of verbal and graphic.
   (d) The subsequent generaion of verbal, sound and graphic is preferable to that of graphic followed by sound.
   (e) The subsequent generation of verbal, sound and graphic is preferable to the simultaneous generaiton of sound and graphic.
   (f) The subsequent generation of verbal, sound and graphic is preferable to that of sound followed by verbal.

The findings indicated that in the positive C2 and C3 feedbacks, the simultaneous generation of sound and graphic, together with other C3 feedbacks were unfavorable. There was no significant preference to the other 73 subtypes.

B. The degrees of preference among K8 students to negative C2 and C3 feedbacks:

1. K8 students preferred the subsequent generation of graphic, verbal and sound to that of graphic followed by verbal or sound by graphic or verbal by sound or sound by verbal.
2. Graphic followed by the simultaneous generation of verbal and sound was preferable to the simultaneous or subsequent generation of verbal and sound.
3. The subsequent generation of sound, verbal and graphic is preferable to that of verbal followed by sound.
4. The simultaneous generation of verbal and sound, followed by graphic was preferable to the subsequent generation of graphic followed by verbal or sound by graphic or verbal by sound.
5. The subsequent generation of verbal followed by graphic is preferable to that of verbal, sound and graphic.

To sum up, in the negative C2 and C3 feedbacks, K8 students are more interested in C3 instead of C2.

C. Degrees of preference among K3 students to subtypes of C3:

1. As the answers were correct:
   (a) K3 students preferred the subsequent generation of graphic, verbal and sound to that of sound graphic and verbal.
   (b) K3 students preferred the subsequent generation of sound, verbal and graphic to that of graphic, verbal and sound, which is, in turn, preferable to the simultaneous generation of graphic and sound, followed by verbal.
   (c) The simultaneous generation of verbal and sound followed by graphic was preferable to the simultaneous generation of graphic and sound, followed by verbal by K3 student.
   (d) K3 students preferred subsequent generation of verbal, sound and graphic to that of verbal, graphic and sound or sound, graphic and verbal or graphic, sound and verbal or the simultaneous generation of graphic and sound, followed by verbal.
2. As the answers were incorrect:
   K3 students preferred the subsequent generation of graphic, sound and verbal to that of sound, graphic and verbal.

D. The degrees of preference among K8 students to subtypes of C3 feedbacks:

1. As the answers were correct:
   There was no significant preference except that the subsequent generation of sound, verbal and graphic was preferable to that of sound, graphic and verbal by K8 students.
2. As the answers were incorrect:
   The subsequent generation of graphic, verbal and sound or sound, verbal and graphic was preferable to the subsequent generation of verbal, sound and graphic by K8 students. Aside from that, there is no significant preference.

## Findings on the repeated feedback

This part was to explore the effectiveness of repeated feedbacks on K3 and K8 students' learning motive. The repeated feedback includes 7 types: verbal, sound, graphic, verbal-graphic ("-" indicating verbal followed by graphic subsequently) verbal-sound, graphic-sound and verbal-graphic-sound.

This study on repeated feedback was more complicated than that on reinforcement feedback to animals, which always reveals an absolute relation between frequency and effect. But, there was no such absolute relation to humans. For example, if a student gives successive correct answers, he or she would be bored by the same positive feedback; on the other hand, he or she would be excited about on positive feedback to a correct answer after the frustration of successive incorrect answers. This research, therefore, was to explore the proportion of students' prefernce to the recurrence of the same feedback.

The process was as follows:

40 questions were divided into 2 parts, with 20 question in each part. The first 20 question were given only one type of positive feedback for each correct answer and one type of negative feedback for each incorrect answer. For example, flower blooming for all correct answers and flower withering for all the incorrect ones in the first 20 questions; a basketball thrown into a backet for correct answers and a basketball thrown out of a basket for incorrect ones in the latter 20 questions. The results are as follows:

A. K3 students' preference to the recurrence to the same feedback:

In the latter 20 questions, when the answers were correct, K3 students' interests were in inverse ratio to the recurrence of the same graphic feedback: (eg. a basketball thrown into a basket, the same result when the answers were incorrect). On the other hand, in the first part, when the answers were incorrect, K3 students' preference was in proportion to the recurrence of the same feedback: (ie. graphic-sound or graphic-verbal or verbal-sound); In the latter part, the prefernce was also in proportion to the recurrence of the same feedback: ( ie. sound or graphic-sound verbal-graphic or graphic-verbal-sound, only that the same verbal feedback was unfavorable). Upon this evidence, that the degrees of K3 students'preference could be concluded, was enhanced in proportion to the recurrence of the same sound feedback when the answers were incorrect.

B. K8 students' preference to the recurrence of the same feedback:

Generally speaking, the degrees of preference was in inverse ratio to the recurrence of the same feedback.

## Conclusion

The results of this study could be summed up as follows:

1. The subtypes of the combination of all the three feedbacks: verbal, graphic and sound were preferable to those of the combination of either two.
2. The degrees of K3 students' preference were enhanced in proportion to the recurrence of the same feedback, while k8 students' preference in inverse ratio; in other words, k8 students' interests dwindle in face of the recurrence of the same feedback.

Some principles for the designing of the combined and repeated feedback could be suggested:

1. In designing the combined feedbacks for both primary and junior high school students, the simultaneous generaiton of verbal, graphic and sound was preferable.
2. To K3 students, the recurrence of the same feedback didn't matter; while to K8 students, it should be avoided.

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# Cooperative Learning and Computer-Based Instruction:

## Achievement, Interaction, and Performance.

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## ABSTRACT

*This study investigated the effects of small group ability composition on the achievement, interaction, and performance of students working in cooperative small groups. High and low ability, sixth and seventh grade, students were assigned to heterogeneous or homogeneous dyads. Students completed a tutorial and a delayed posttest. Results indicated that low ability students interacted more and completed the instruction more efficiently in heterogeneous than in homogeneous groups. In addition, high ability students completed the instruction more efficiently in homogeneous groups.*

Many believe the computer has the potential to raise educational standards above their present level of mediocrity (National Commission on Excellence in Education, 1983). To that end, schools across the country have made major investments in computer equipment. Becker (1986) reported that most elementary schools in the United States have at least five computers, and half of the secondary schools have at least 15 or more computers.

Despite the potential benefits (Kulik, Bangert, and Williams, 1983), the computer has had little influence on the school curriculum (Hativa, 1986). Instead, the computer is often used for cognitively low-level tasks or to deliver enrichment exercises for advanced students. While these applications may facilitate classroom management and promote learning of basic skills, the influence of CBE on the curriculum has far greater potential.

Because of this lack of influence on the curriculum some believe the computer will soon fade from the educational limelight; however, others remain hopeful for the future of the computer in education. Whiteside and James (1986) warned that the computer may face the same demise as other educational technologies such as teaching machines and programmed instruction. Similarly, Maddux (1986) warned that the "pendulum syndrome" (p. 27), a period of optimism followed by disillusion and eventual rejection, was beginning to afflict CBE. Conversely, while identifying many barriers that confront the integration of the computer into the curriculum, Hannafin, Dalton, and Hooper (1987) were optimistic about the future of CBE and proposed several solutions to the existing problems. Above all, they maintained that meaningful progress, toward computer integration in the schools, was contingent upon "...fundamental changes in the structure of the school and classroom..."(p. 17). Without change, improvement in education is unlikely.

One such structural change involves a shift from the traditional model of students working at computers individually, to one where students work in small groups. This small group model is commonly referred to as cooperative learning. When compared with more traditional classroom models cooperative learning often improves achievement and is credited with significant improvements in students' attitudes.

Research often suggests that cooperative learning improves achievement when compared to other methods. For example, following a meta analysis of 122 studies, Johnson et al. (1981) concluded that cooperative goal structures are superior to competitive and individual goal structures for promoting achievement and productivity.

In addition to improved achievement and productivity, cooperative learning also has important social benefits (Slavin & Oickle, 1981). Students who work in groups often improve self esteem and attitudes toward their peers and school work, and are often more altruistic toward group members than to other students in class. Cooperative learning also tends to improve race relations among group members of diverse races and cultures. Cooperative learning may also have important implications for learning from interactive technologies. Individualized instruction implies social isolation and highlights the financial constraints associated with providing a computer for each student. CBE has also been criticized as impractical due to the limited number of computers in the schools (Reed, 1986). These criticisms often assume that individual students will be isolated at a computer instead of working in groups of two or more. In many cases, individual learning at the computer may be both unnecessary and unwise.

In contrast to cooperative learning, individual models present obstacles to the implementation of CBE. Students who work alone at the computer for extended periods may become lonely, bored, or frustrated resulting in lower achievement motivation and a sterile, impersonal, learning environment. Moreover, individual learning at the computer also denies the opportunity for students to interact. Students who work in isolation also lose the opportunity to model effective learning styles: Students who cooperate may observe and adopt unfamiliar strategies and techniques that facilitate learning.

Although cooperative learning research from the traditional classroom may transfer to cooperative learning at the computer, possible limitations exist. The computer, as a learning tool, may create a fundamentally different learning environment. The computer possesses the potential to vary the instructional sequence according to the cognitive demands of the learning task and the cognitive style of the learner, and to deliver immediate and varied feedback and reinforcement to a degree unparalleled by other educational media (Carrier & Sales, 1987). It may, therefore, be difficult to compare directly learning from the computer with other more traditional media. Consequently, research is required to verify the generalizability of cooperative learning research and to establish the parameters for cooperative learning at the computer.

Although historically little research had been conducted, recent studies support the efficacy of cooperative learning at the computer. Johnson, Johnson, and Stanne (1985) investigated the relative effectiveness of learning cooperatively, competitively, or individually from the computer. The results of the study indicated that both the quantity and quality of achievement were highest for students in cooperative groups. Further research by Johnson, Johnson, and Stanne (1986) supported the initial finding and also indicated the social status of females in the groups increased in cooperative groups. These studies suggest that cooperative learning may be effective in both traditional and computer environments and that existing cooperative learning research may transfer to cooperative learning with the computer.

The issue of whether ability group composition influences the achievement of students working in cooperative small groups has received little attention. Instead, cooperative learning methods often group students heterogeneously, by ability, based more on the goal of promoting pro-social relationships than on improving learning per se (e.g., Sharan, Kussell, Sharan, & Bejarano,1984). Alternatively, heterogeneous group composition is perceived as a strategy to improve the performance of disadvantaged students (Slavin & Oickle, 1981). Although cooperative learning has been found to improve achievement for both white and minority students the greatest gains are often made by minority students. While these pro-social and egalitarian educational goals are undeniably valuable, they do not address the comparative effectiveness of heterogeneous versus homogeneous cooperative groups.

Although, theoretically, homogeneous group composition appears to offer advantages, in practice there may be risks associated with grouping students by ability. Perhaps the most compelling argument against homogeneous grouping is that ability grouping may create academically elite groups. Since social class and ethnic background tend to determine ability group composition, homogeneous grouping may serve to increase the divisions between the socially advantaged and disadvantaged. While high ability students may thrive, homogeneously grouped low ability students may find success elusive: The quality of instruction is often poorer in low ability than in high ability classes; poor achievement in low ability groups may be a self-fulfilling prophecy; and, groups containing only low ability students may suffer from the lack of cognitive stimulation, and the availability of effective learning behaviors, modelled by more able students.

An unresolved issue concerning heterogeneous cooperative learning groups is whether improved performance by lower ability students is achieved at the expense of higher ability students. Yager, Johnson, and Johnson (1985) supported the efficacy of heterogeneous group composition for high, medium, and low ability students. However, though this research compared students in heterogeneous groups with students working individually, it did not directly compare heterogeneous with homogeneous groups. This research supports the efficacy of group versus individual learning, but should not be used to compare the relative effectiveness of heterogeneous and homogeneous groups.

Other research suggests heterogeneous group composition may have negative consequences for some students. Hooper and Hannafin (1988), for example, found that substantial achievement gains for low ability students in heterogeneous groups were gained, in part, at the expense of their high ability counterparts. Further, Webb (1982a) found that middle-ability students in homogeneous groups obtained higher achievement than middle-ability students in heterogeneous groups, suggesting that additional research is required to clarify the issue of group ability composition.

Heterogeneous group composition offers many social advantages and may improve the performance of some students. However, the effects of group composition on the achievement of all ability groups must be established prior to the adoption of heterogeneous grouping for cooperative learning. Consequently, research is required to compare directly the effects of grouping students in homogeneous and heterogeneous groups.

Social psychology research suggests factors that may negatively impact motivation within small groups. Among these factors are "free rider" and "sucker" effects (Kerr & Bruun, 1983). A free-rider is one who perceives no need to provide input due to the effort of other group members; sucker effects exist when group members perceive a lack of productivity from capable group members. The resulting loss of motivation may reduce the effectiveness of cooperative learning.

Motivation losses may be reduced by increasing individual group member accountability (Slavin,1983a). Accountability may be promoted by providing group rewards or creating task interdependence. With task interdependence, students are responsible for unique tasks and incentives are provided for students to learn from each other. However, if students are not sufficiently motivated some other strategy may be necessary to ensure interaction between all group members.

One technique to promote interaction requires individual group members to master quizzes embedded in the instruction. Groups with students who fail to demonstrate mastery review the lesson content before repeating the quiz. The lesson continues only when mastery has been demonstrated by all group members. This technique may reduce damaging free rider and sucker effects by motivating more able to help less able group members. Less able group members may then invest greater mental effort to master instruction. Research is required to test the effectiveness of this strategy.

Cooperative learning studies often assume that group members have an implicit understanding of how to tutor. Students are often told to use the strategies they believe to be most effective for helping other group members. Research suggests that these "default" strategies may not effectively mediate achievement in small groups (McKellar, 1986). The ability to tutor effectively is probably affected by any teaching techniques the tutor has received.

Research suggests that when students are trained in specific cooperation techniques performance on ensuing tasks is enhanced. Spurlin, Dansereau, O'Donnell, and Brooks (1988) found that students who were instructed to summarize during reading, performed significantly better on a test than students who used personal study methods. Swing and Peterson (1982) examined the effectiveness of a training program designed to increase and improve interaction during small group learning. Students were taught how to interact, and techniques to provide effective explanations to group members. Results from this study indicated that trained students were involved in more task-related interaction than were students in a control group. Further, task-related interaction coincided with improved performance of both high and low ability students working in heterogeneous groups. Consequently, students in cooperative learning groups should be trained in those behaviors believed most likely to enhance cooperation and achievement.

The purposes of this study were: 1) to examine the effects of heterogeneous versus homogeneous group ability composition, together with a strategy to mediate intragroup cooperation, on achievement; 2) to investigate the influence of ability group composition on the quantity of cooperation within groups, and; 3) to examine the influence of the cooperative groupings on student completion rates of the lesson content.

## METHODS

### Subjects

A sample of 125 sixth and seventh grade school students completed the study. Only high or low ability students were selected for the study. Ability was determined by performance on two measures: The California Achievement Test and performance on a pretest.

### Materials

#### Pretest

A pretest contained 30 questions. These questions were essentially parallel to the task performed during instruction. The K-R 20 overall reliability for the pretest was .92.

#### Cooperation Training

Training was designed to facilitate effective intragroup interaction and cooperation. The first of two training sessions emphasized peer awareness. Peer awareness was introduced through the game "Broken Circles." Broken Circles is a puzzle that cannot be completely solved unless students are aware of the difficulties experienced by other group members, and are willing to sacrifice individual success for the good of the group. Each member of a group, of between four and six members, was given an envelope containing pieces of a circle. The objective of the game was for every member to create a circle. Interaction was limited: Subjects were permitted to offer pieces, but talking was not allowed and taking game pieces from other group members was forbidden. The second training session promoted oral summarization between group members. Students in dyads completed three tasks that involved rule identification and summarization to a partner. Students were told to identify rules which governed each task and to take turns summarizing the rules to each other. When a task was completed, students were asked at random to explain the rules. Between each task, feedback concerning the appropriateness and effectiveness of student behavior was provided.

#### Training Observers

Five observers were trained, using pre-recorded videotape recordings, in classroom observation and data collection processes. Upon completion of the training the ratings were analyzed to determine the reliability of the raters from one rating to another (K-R 21=.99) and the inter-rater reliability compared to a target score (which was more than 90%).

#### CBI Lesson Content

A novel arithmetic symbol system was developed. This symbol system was selected because it was rule based and easily modified to alter the difficulty of the content. The symbol system reduced the effects of prior knowledge since the only essential prior knowledge involved the ability to perform calculations with the four basic arithmetic operations. Further, the teaching function of the instruction was low since a major requirement of the lesson involved the mapping of existing conceptual understanding to a novel symbol system.

The tutorial was presented via the computer and comprised three phases. In each phase, students received instruction, answered related practice questions (each question was followed by immediate feedback), and completed an embedded quiz. Answers to the quiz were displayed via the computer. Groups that achieved mastery on the quiz automatically began the next phase of instruction. Alternatively, groups were told to discuss their errors and to attempt a parallel version of the quiz when they thought they were ready. This protocol continued either until mastery was demonstrated or until the quiz had been repeated twice. After two repetitions the next phase of instruction began.

#### Lesson Versions

Two versions of the computer-based tutorial were designed reflecting different approaches to assessing mastery and readiness to continue the instruction. The lesson content and instructional decisions were identical; however, the lessons differed in the procedures to be followed when completing the embedded quizzes and assessing content mastery.

#### Individual responsibility (IR)

Students cooperated during the lesson, but answered the embedded quizzes individually without conferring with their partner. When both students completed a quiz they exchanged, graded, and scored each other's quiz booklets. Correct answers to the quizzes were delivered via the computer. The lower score obtained by either group member constituted the group score and was used to determine group mastery.

**Group responsibility (GR)**

Students cooperated during the lesson and collaborated on the embedded quizzes to produce a single quiz version. Students scored their own quizzes from correct answers delivered via the computer. The combined score obtained on the quiz was used to determine group mastery.

**Posttest**

A posttest contained 40 questions divided evenly among fact, application, problem solving, and generalization. The questions were presented in a 10 page booklet in which one of each question type was included on most pages. One and one-half minutes were allocated to complete the answers on each page. The overall K-R 20 posttest reliability was 0.89.

**Experimental Design**

The study employed a 2X2X2(X4) mixed effects factorial design. The between-subjects factors included Ability (High, Low), Cooperative Group Composition (Heterogeneous, Homogeneous), and Responsibility (Group, Individual). The within subjects factor Level of Learning, included Fact, Application, Problem Solving, and Generalization.

Cooperation data were analyzed through a completely crossed 2X2X2 fixed effects factorial design. Factors included Ability (High, Low), Cooperative Group Composition (Heterogeneous, Homogeneous) and Responsibility (Individual, Group).

Completed embedded quizzes were analyzed through a 3X2(X3) mixed effects factorial design. The between-subjects factors included Instructional Group (Homogeneous Low, Homogeneous High, Heterogeneous) and Responsibility (Individual, Group). The within subjects factor included the number of quizzes completed for each of three sets of embedded quizzes.

Follow-up analyses were performed through Neuman-Keuls or complex contrast procedures.

**Treatments**

**Ability**

High ability students scored at or above the 70th percentile for mathematical performance on the California Achievement Test, and above the mean on the pretest. Low ability students scored at or below the 40th percentile for mathematical performance on the California Achievement Test, and below the mean on the pretest.

**Cooperative Group Composition**

Each heterogeneous group contained two students, one from each ability group. Each homogeneous group contained two students from the same ability group.

**Responsibility**

Students in the IR treatment demonstrated individual mastery of the embedded quizzes before continuing the lesson. Mastery for students in the GR condition was determined on the basis of group generated responses.

**Dependent Measures**

While completing the experiment, the amount of cooperation produced by each group member was recorded. These data were used for the cooperation analysis. When subjects completed the embedded quizzes, the number of quizzes completed by each group before demonstrating mastery was recorded. These data were used for the embedded quizzes analysis. After completion of their treatments, subjects received a written posttest. The posttest contained fact, application, problem solving, and generalization questions. The scores obtained on these measures were used for the posttest analysis.

**Procedures**

The pretest was administered to all potential subjects to classify students as high or low ability. All selected students completed two 45-minute, training sessions during a four-day period. Students were told they would work in dyads, that each dyad would have an opportunity to win a $10 prize, and that success would be influenced by the ability to cooperate.

Students were randomly assigned, within ability groups, to treatment groups. Sets of 20 students were placed in dyads, each dyad was assigned to a computer, and completed either the GR or the IR version of the tutorial. Students from the IR condition were given separate quiz booklets to be completed without help from their partners. Students who completed the GR condition were given a single quiz booklet to complete cooperatively. Students were allocated 45 minutes to complete the tutorial. All students completed the instruction phase of the tutorial, however, not all groups completed the mastery quizzes for the final section before time expired and students were told to stop.

Groups were observed periodically, by the trained raters, during the instructional treatment to assess the amount of cooperation that took place within the groups. One unit of cooperation was recorded, regardless of temporal length, each time an instance of cooperation was observed.

Each observation lasted five minutes. Each unit of cooperation, and any related noteworthy events were recorded on a cooperation sheet. Raters circulated in the room to ensure that every group was observed for at least five minutes in each 10-minute period.

Subjects completed the posttest, individually, five days after the lesson. Ten absentees completed the posttest one week after the others. After completion of their treatments, subjects received a written posttest which was answered individually.

## RESULTS

### Achievement

**Main Effects**

A significant difference was found for Ability, $F(1,117)=77.64$, $p<.001$. High ability students scored higher than low ability students on the posttest (means 81.33% and 58.81% respectively). A significant difference was also found for Level of Questioning, $F(1,117)=191.91$, $p<.001$. Differences between posttest scores were significantly different among all levels of questions. Scores were highest for factual questions (mean = 96.80%), followed by application (mean = 77.23%), generalization (mean = 58.16%), and problem solving questions (mean = 47.20%). A marginally significant difference was found for responsibility, $F(1,117)=3.33$, $p<.071$. Students working in the group responsibility treatment scored higher on the posttest (mean = 71.67%) than students working in the individual responsibility treatment (mean = 67.54%).

**Interaction Effects**

A significant interaction was found between Level of Questioning and Ability, $F(3,351)=20.38$, $p<.001$. Follow-up complex contrasts showed that differences in achievement between high and low ability students increased as the questions became more complex (see Figure 1.) Contrasts were statistically significant between high and low ability students for fact vs. application, $p<.05$, fact vs. problem solving, $p<.05$, fact vs. generalization, $p<.05$, and application vs. problem solving questions, $p<.05$. In each case, the contrast was characterized by a greater achievement decrement for low ability subjects compared to high ability subjects.

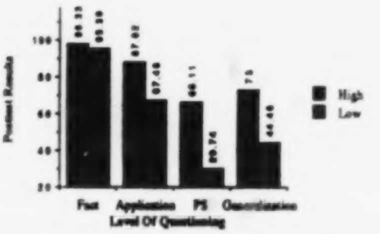

Figure 1: Interaction Among Level of Questioning and Ability

## Cooperation

### Main Effects

A significant difference was found for Responsibility $F(1,117)=18.29$, $p<.001$. Students in the Group Responsibility condition (mean = 11.80) cooperated more than students in the Individual Responsibility condition (mean = 8.87). A significant difference was also found for Ability $F(1,117)=10.91$, $p<.001$. High ability students (mean= 11.67) cooperated more than low ability students (mean = 9.13).

### Interaction Effects

A significant interaction was found between Ability and Group Composition, $F(1,117)=4.17$, $p=.043$, see Figure 2. Follow-up analysis indicated that low ability, homogeneously grouped, students cooperated significantly less than students in other groups.

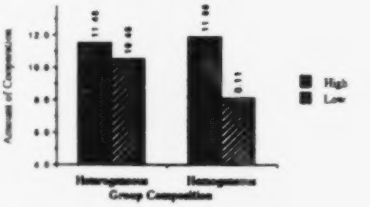

Figure 2: Interaction Among Ability and Group Composition

## Embedded Quizzes

The number of quizzes attempted before demonstrating mastery, at three points during the instruction, comprise the data used for this analysis. Each set of three possible quizzes was treated as a separate within-subjects, repeated measures factor. For the purposes of data analysis, heterogeneous high and low ability grouped were collapsed into a single group; heterogeneous. Homogeneously grouped high and low ability students were categorized as homogeneous high or homogeneous low analysis groups. The metric used for this analysis represents a reverse scale. Higher scores indicate greater difficulty in mastering the lesson content.

Two analyses were performed on the embedded quizzes data. The first analysis included data from all three sets of embedded quizzes. A second analysis was performed because of data missing from the first analysis. Due to time constraints, some groups did not attempt any of the embedded quizzes after the final instructional phase. Other groups were forced to terminate the instruction before demonstrating mastery of the last section. Inspection of the data indicated that only a few heterogeneous groups and homogeneous low groups were forced to end the lesson before completing the final set of embedded quizzes. Consequently, the second analysis was completed on a complete data set, which included the number of embedded quizzes attempted by each group after each of the first two instructional phases.

### Analysis 1

A significant main effect was found for Instructional Group $F(2,52)=4.77$, $p<.013$. Follow-up analysis indicated that significantly more embedded quizzes were attempted in homogeneous low groups (mean = 5.18) than in the heterogeneous and homogeneous high groups (means 4.12 and 4.07 respectively).

A significant main effect was also found for Quizzes $F(2,104)=6.84$, $p<.002$. The increases in the number of attempts needed to demonstrate mastery of successive sets of embedded quizzes were both significant (means = 1.35, 1.52, and 1.73 respectively).

### Analysis 2

The second analysis also included a main effect for Instructional Group $F(2,57)=3.38$, $p<.041$. Follow-up analysis indicated that significantly more embedded quizzes were attempted in homogeneous low groups (mean = 3.37) than in the heterogeneous and homogeneous high groups (means 2.86 and 2.40 respectively). In addition, a main effect was found for Responsibility $F(1,57)=6.54$, $p<.013$. Students attempted significantly more embedded quizzes in the Individual Achievement condition (mean = 3.32) than in the Group Achievement condition (mean = 2.50). A significant main effect was also found for Quizzes $F(1,57)=4.36$, $p<.041$. Students attempted significantly more quizzes in successive sets of embedded quizzes (means = 1.35 and 1.55 respectively).

### Correlation Analysis

Post hoc correlation analyses were performed to identify relationships between cooperation during the experimental treatment and achievement on the posttest, in each of the four analysis groups. Significant correlations between achievement and cooperation were found for high ability students in heterogeneous groups $r(29)=.472$, $p<.01$, and for low ability students in heterogeneous groups $r(28)=.558$, $p<.01$. Further analyses attempted to determine whether the relationships were significantly greater for high ability students, and for low ability students, in heterogeneous versus homogeneous groups. Using Fisher-Z transformations, significant differences were found between high ability students in heterogeneous and homogeneous groups $Z=4.35$, $p<.01$, and between low ability students in heterogeneous and homogeneous groups $Z=8.65$, $p<.01$.

## DISCUSSION

A significant interaction was found between Ability and Group for the amount of intra-group cooperation. The interaction was characterized by low-ability students interacting less in homogeneous groups than in heterogeneous groups. In contrast, high-ability students and low-ability students in heterogeneous groups cooperated at comparable levels. Further analysis revealed that low-ability students cooperated almost 30 percent more in heterogeneous than in homogeneous groups.

Why did low-ability students interact less in homogeneous than in heterogeneous groups? Several explanations help to account for this finding. Low-ability students may not have been trained sufficiently in cooperation techniques and, consequently, may have lacked knowledge about how to cooperate effectively. With additional training, low-ability students in homogeneous groups may have cooperated more effectively.

High-ability students may have established more effective group norms than did low-ability students in homogeneous groups. High-ability students in heterogeneous groups may have established interaction patterns that virtually forced low-ability partners to cooperate. In contrast, low-ability students may not possess sufficient interaction skills to cooperate effectively.

Low-ability students' verbal communication skills may be insufficient to enable effective cooperation; low ability students may simply not understand the lesson content well enough to give satisfactory explanations (Webb, 1984). Further, low-ability students may be unable to generate the explanations believed to be important for effective cooperative learning. Based on Rumelhart and Norman's (1978) description of the learning stages, low-ability students are believed to be unable to generate in-depth explanations and summaries. However, the precise nature of the cooperation was not recorded in this study. Therefore, the conclusion that students in low-ability groups were unable to summarize effectively, or provide in-depth explanations, is implied but cannot be verified.

Although no measure of quality exists, the quality of interaction may have been higher in heterogeneous than in homogeneous groups. Correlation analyses were performed to identify relationships between interaction and achievement. Results indicated significantly stronger relationships for high and low ability students in heterogeneous groups than for similar ability students in homogeneous groups. Heterogeneous grouping may have promoted effective teacher/student relationships between group members. However, in homogeneous groups student interaction may have focussed more on technical procedures than on processes that promoted student processing.

From a psychological perspective, infrequent interaction may have important implications for achievement. Webb (1987) suggested that the effectiveness of cooperative learning may be greatest for students who interact the most. Those who learn least from cooperative learning may be students who cooperate infrequently and receive few explanations from other group members. Students who interact may support each other's learning needs, experience the benefits of giving and receiving help, or experience other cognitive benefits associated with interaction.

From a sociological perspective, reduced cooperation may inhibit the goal of improving affective behavior. Allport (1954) concluded that racial prejudice is reduced not simply by social contact, but by interaction that promotes knowledge and acquaintance of group members. When interaction is restricted, the goal of breaking down racial barriers is more complex. Although Allport wrote specifically with the goal of improving race relations, higher levels of interaction may facilitate the goal of improved social relations between group members in general. When students do not interact, or the amount of cooperation is low, the goal of improving attitudes among group members may be obstructed.

Interaction among group members is one of the principal reasons for the effectiveness of cooperative learning; group learning is likely to be less effective when cooperation is low. Low ability students, grouped heterogeneously, cooperated as much as high ability students. High ability students cooperated at approximately the same levels in heterogeneous and homogeneous groups. Consequently, low ability students should be grouped heterogeneously to promote interaction among group members.

An important finding concerns the effect of group composition on progress during instruction. In this study, progress was gauged by the number of embedded quizzes attempted by each group before mastery was demonstrated. Since failure to achieve mastery criterion required additional quizzes, progress was less efficient when groups attempted greater numbers of embedded quizzes. Group progress data were analyzed twice, due to missing data on the first analysis. In both analyses a significant effect was found for the grouping variable, Type. The grouping variable included three levels: homogeneous high, heterogeneous, and homogeneous low. Follow-up analyses indicated that groups containing only low-ability students attempted significantly more embedded quizzes than students in high-ability and heterogeneous groups. The second analysis also indicated that students in heterogeneous groups attempted more embedded quizzes than did high-ability students in homogeneous groups. These results suggest that the progress of low-ability students was hindered in homogeneous groups, while the efficiency of high-ability students may have been hindered in heterogeneous groups when, presumably, the less able group members hampered the progress of the group.

Together these findings present a clearer picture of the importance of group composition. Low-ability students cooperated more and were more efficient in heterogeneous than in homogeneous groups, thus demonstrating more efficient learning in heterogeneous groups. Although the amount of cooperation was equal, high ability students attempted fewer embedded quizzes in homogeneous than in heterogeneous groups, thus suggesting more efficient learning in homogeneous groups. Future research should investigate the effects of ability group composition on learning efficiency.

The predicted Ability by Group interaction for achievement was not statistically significant. Low-ability students were hypothesized to benefit more from heterogeneous than homogeneous group composition, without an accompanying decrement in achievement for high-ability students in heterogeneous versus homogeneous groups. However, although the differences between the posttest means were not statistically significant the means were in the predicted directions. Ignoring the minimal differences between groups on factual learning, posttest achievement was only 3 percent higher for high-ability students in homogeneous groups than in heterogeneous groups. However, posttest achievement was 13 percent higher for low-ability students in heterogeneous groups than in homogeneous groups.

Similar results were found in previous research. Hooper and Hannafin (1988) concluded that heterogeneous group composition improves the achievement of low-ability students at little cost to high-ability group members. Amaria, Biran, and Leith (1969), Webb (1982c), and Larson et al. (1984) reported achievement gains for low ability students in addition to small achievement gains for high ability students in heterogeneous groups. However, little evidence was found to support Beane and Lemke (1971) who concluded that heterogeneous grouping was only beneficial for high ability students.

Heterogeneous grouping appears to offer additional psychological advantages. Schunk (1987) noted that heterogeneous groups are more effective than homogeneous groups for modeling appropriate behavior. "Children should be more likely to pattern their behavior after models who perform successfully than to emulate less competent models. In other words models who are dissimilar in competence to observers exert more powerful effects on children's behavior" (p.161). Low-ability students may, therefore, be more likely to learn effective behaviors modeled by high-ability students in heterogeneous groups than from other low-ability students in homogeneous groups.

Group composition has important sociological implications for education, especially when learning gains for one group are achieved at the expense of even small achievement losses for another group. Equity concerns will continue to influence group composition until a model is shown to maximize achievement for students of all abilities. Until an optimal model is identified, educators may profit more by comparing the effectiveness of heterogeneous cooperative group composition with traditional methods that feature individual learning, than by contrasting heterogeneous with homogeneous cooperative group composition.

Decisions concerning ability group composition should be examined from a broader perspective than simply academic achievement. Although this study focussed on the cognitive outcomes of ability grouping there are many important social and affective outcomes which help to justify heterogeneous grouping for cooperative learning groups. Indeed, a primary goal of group learning is to create an environment in which children from disparate backgrounds interact. It is, perhaps, one of the most important goals of education to prepare children to function effectively within a multi-cultural, multi-dimensional society. When grouped heterogeneously students are likely to experience diverse cultures, social classes, and physically disadvantaged students. However, homogeneous grouping is more likely to perpetuate existing social stereotypes and prejudices.

The free rider postulate received little support in this study. A marginally significant main effect was found for Responsibility on the posttest, indicating that students who collaborated when completing the embedded quizzes scored higher on the posttest than students who completed the quizzes individually. This finding contradicts the hypothesis that students who completed embedded quizzes individually would achieve higher scores on the posttest than students who collaborated on the embedded quizzes.

One explanation for this finding is that increased interaction resulted in higher achievement. Students in the Group Responsibility condition, who collaborated during the embedded quizzes, interacted significantly more than students in the Individual Responsibility condition. If higher levels of interaction improve achievement in cooperative groups (Webb, 1987), then students who collaborated during the embedded quizzes may have benefitted from the increased interaction and, as a result, demonstrated higher achievement scores on the posttest.

The issue of social dilemmas, such as free riders and social loafing, may be more important in larger groups than in dyads. The loss of motivation associated with social loafing, for example, increased with group size (Latané, Williams, & Harkins, 1979). Similarly, Kerr and Bruun (1983) noted that social loafing increased with group size, even when individual accountability was high. In larger cooperative groups, containing from three to five students, individual members may have less influence over group behavior. When only two students comprise a group, individual accountability and motivation may be higher than in larger groups: Members may form a coalition, and individual effort may be more highly valued. When a similar achievement contingency was used with groups containing from three to five students, for a postsecondary sample, performance increased for all students across a variety of questions (Hooper, Ward, Hannafin, & Clark, in press). Further research is required to determine whether free riders influence the effectiveness of cooperative groups for larger groups of secondary students.

A significant interaction was found between Ability and Levels of Questioning for posttest achievement. The interaction illustrated that achievement differences between high and low-ability students were not statistically different for fact questions; however, as the level of questioning became more complex, achievement losses were greater for low-ability than for high-ability students. Although students may perform equally well on simple tasks, the effects of group composition may only be apparent for more complex questions. This conclusion parallels findings that group differences were greater for higher-level cognitive functioning than for cognitively low learning (Sharan, Ackerman, & Hertz-Lazarowitz, 1980). Apparently, group interaction has little influence on learning factual information.

Several implications for future research are suggested. Researchers should investigate the quality, instead of the quantity, of interaction in heterogeneous and homogeneous groups. Only a gross measure of interaction was recorded while the subjects completed the experimental treatment. However, correlation analyses indicated that the relationship between interaction and achievement was significantly higher for high and low ability students in heterogeneous than in homogeneous groups. This result suggests that the quality of interaction may have been greater in heterogeneous than in homogeneous groups. Future study should identify the nature of this interaction.

The content of cooperation training should also be examined. Cooperation training should promote behaviors which are most likely to result in effective intra-group interaction. Therefore, researchers should examine groups to identify the interaction pattrens which produce the strongest effects on group learning. Once identified, effective techniques may be trained directly to group members to improve group interaction and performance.

The issue of free riders in cooperative groups should be examined in groups containing more than two students and the influence of free riders, and other social effects, should be examined in an extended research study. When groups include more than two persons, free riding is more apt to occur. Researchers should, therefore, investigate whether achievement contingencies are important to maintain individual accountability and keep group members on-task. Also, free rider effects may be less prevalent in a short experimental study than when cooperative learning is implemented for an extended time period. High student motivation is less likely to be maintained by novelty effects in a more lengthy study than in a short experimental study.

The effects of group composition on all ability groups should be examined. In this study, group composition involved only high and low-ability students. However, research suggests that group performance may be influenced when average ability students are grouped with high and low ability students (Webb, 1982a). Average ability students were excluded from student interaction when groups contained high, average, and low ability students. Consequently, average ability students worked more effectively in homogeneous than in heterogeneous ability groups. However, if students are first trained to interact effectively, middle ability students may not be excluded from group interaction and may benefit from heterogeneous group composition.

Finally, researchers should compare the effectiveness of training domain-independent with content-specific interaction techniques. In this study, students were trained to summarize to promote interaction between partners. However, training may be more effective for other lesson content when the interaction techniques are tied closely to the cognitive requirements of the task. Future research is required to examine this issue.

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# IDD Advisor: Using Expert Systems as an Intelligent Job Aid for Instructional Development

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The IDD Advisor is an on-going project designed to use expert systems as an intelligent job aid for assisting an instructional designer, teacher, or course writer to follow the instructional design and development (IDD) process. The IDD Advisor is also an intelligent front end to a database containing the components of the instructional sequence being developed, so that as instructional decisions are made, the results of those decisions are stored in a database.

The IDD Advisor is a structured rule-based expert system with several rule sets. The arrangement of these rule sets is illustrated in the context tree for the IDD Advisor in Figure 1. Each node represents a separate rule set which, in effect, functions as a separate knowledge base.

Insert Figure 1 here.

The first rule system encountered is the executive menu, which queries the user to ascertain if this is a new design project. If the project is new, it executes the project analysis rule system. If the user is adding onto an existing project, the executive menu enables the user to select the rule system that she or he needs to work in.

For new projects, the user would typically work through a project analysis rule set first. This rule set collects information about the project and establishes whether the project is instigated by a performance problem or whether it involves new systems, automatic training, or educational development. If the project is predicated on a performance problem, the project analysis module will access the performance analysis module. If the project is not problem-based, the project analysis module will access the needs assessment rule set. Regardless of the purpose of the project, the project analysis module, as do all of the modules, saves information about the project.

The performance analysis rule set leads the user through a typical performance analysis: identify the goal performance state, the current state, determines the discrepancy, determines the cause and classifies the cause of the performance problem. If the problem is caused by motivational and environmental problems, the user would exit the system. In the future, motivational and environmental problem rule sets may be developed. If the problem is determined by the performance analysis module to be a skill/knowledge problem, then the problems are recorded and indexed in the database, and the user is led to the task analysis model.

The needs assessment rule set is accessed if the project analysis determines that the project is not problem-based. Users are led through the decision-making on the needs assessment technique, question form, and question type in order to construct the questions. The outcome of these modules is a needs assessment instrument which is stored in the database. After collecting the data, users would access the needs assessment interpretation rule set to help them interpret the outcome. The users would then be led to the task analysis module.

The task analysis process has three rule sets that assist the user. The first module helps the user select the most appropriate task analysis technique from a list of 27 found in Jonassen, Hannum & Tessmer (1989). A sample of the rules in this rule set is illustrated in Figure 2. The technique rule set may access the tool rule set to determine the most appropriate information gathering tools. Finally, the Task analysis rule set will help users to interpret and analyze the information they collect. The sub-tasks will be stored in the database.

Insert Figure 2 here.

Following the task analysis, the objective writing and test item writing rule sets will access the tasks stored in the database and help the users to convert them to objectives, classify those objectives, and write test items that measure those objectives.

Having completed the test items, the users would then access the instructional design modules, which would help them to select the necessary presentation forms and instructional strategies for the sequence of tasks/objectives determined in the previous modules. Again, the rule sets will interact with the database by pulling the information out of the database and using it to help the users to select the instructional lesson components.

Finally, the users could access the delivery module to access advice on selecting the appropriate delivery system for presenting the instructional components. The system may be expanded to include a message design module in the future.

## Software Systems

The prototype knowledge bases run under VP Expert from Paperback Software. VP Expert is a structured, rule-based system that possesses the power of much larger and more expensive expert system shells. Yet it is very inexpensive. The information base is being created in dBase III+ from Ashton-Tate. dBase III+ is a relatively inexpensive package that has become one of the referent standards for business. VP Expert can interface with dBase files in order to function as an intelligent front end. Both software packages run on MS-DOS personal computers (IBM or compatible). The reasons for selecting the software packages currently being used to develop IDD Advisor are pragmatic. They are inexpensive, readily available, and commonly used. That makes the system more useful to a wider range of users. Most businesses, agencies, and educational institutions own dBase III+, and VP Expert is available for less than $100, so that the initial investment, assuming that MS-DOS computers are available, is minimal. MS-DOS machines are currently the de facto standard for businesses, so they should be readily available as well. If VP Expert becomes too limited, the system may be shifted to a more powerful structured rule-based system shell.

## Process for Developing the IDD Advisor

Harmon (1986) describes a seven step process for design, developing, and implementing expert systems.

1) Front end analysis - performance problem and cost benefit
2) Task analysis
3) Prototype development - development of a small version to test feasibility and desirability of system
4) System development - develop entire system
5) Field test the system
6) Implementation - disseminate the system
7) Maintenance - upgrade the system and provide user support.

## Next Phase of Project

Rule-based systems have limited instructional potential. Users may model the reasoning implied by the rules. The extent to which such modelling or internalization would occur from repeated use of an expert system needs to be researched. The second stage of this project would attempt to add some more intelligence and instructional capability to the system. The result of the next phase would be an IDD Advisor/Instructor.

The operational goal of the IDD Advisor/Instructor would be to meld emerging computer-based tools and technologies. Figure 3 illustrates the arrangement of these. If we assume that a realistic goal of instruction is to map the knowledge of an expert onto a novice, then the first problem is how to map that knowledge. Jonassen (1989) used multi-dimensional scaling techniques to map the structure of concepts in instructional systems technology. We need to map the cognitive structure of both the expert instructional designer and the novice. The schemata or declarative knowledge of the expert designer can be represented by semantic networking programs (Fisher et al, 1988; Kozma, 1987) and by the object-oriented frames of the expert system. The experts procedural knowledge may be represented by the structured rule sets resulting from the first phase of the IDD Advisor. By mapping the semantic network of the novice at any point, a description of his or her declarative knowledge is possible. Matching that conceptualization with the frames stored in the expert system, the gaps in the novices declarative knowledge can be identified. Those gaps that are identified can drive the tutor, so that the novice may receive tutoring along with the solutions as she or he works through the expert system.

This second phase is obviously only in the conceptual stage. Tentatively, it will be developed using Gold Works, a hybrid expert system from Gold Hill Computers. The rule sets will have to be transferred from the IDD Advisor into Gold Works. The declarative knowledge will have to be built into the object-oriented frames. A semantic networking program will have to be built in the IBM environment and then interfaced to Gold Works. Finally a tutor will have to be built which receives its knowledge from Gold Works. The problems are considerable, but the product would represent a significant advance.

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Insert Figure 3 here.

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## REFERENCES

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Kozma, R.B. (1987). The implications of cognitive psychology for computer-based learning tools. Educational Technology, 27(11), 20-25.

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Figure 1
Context Tree
for Instructional
System Development
Expert Systems

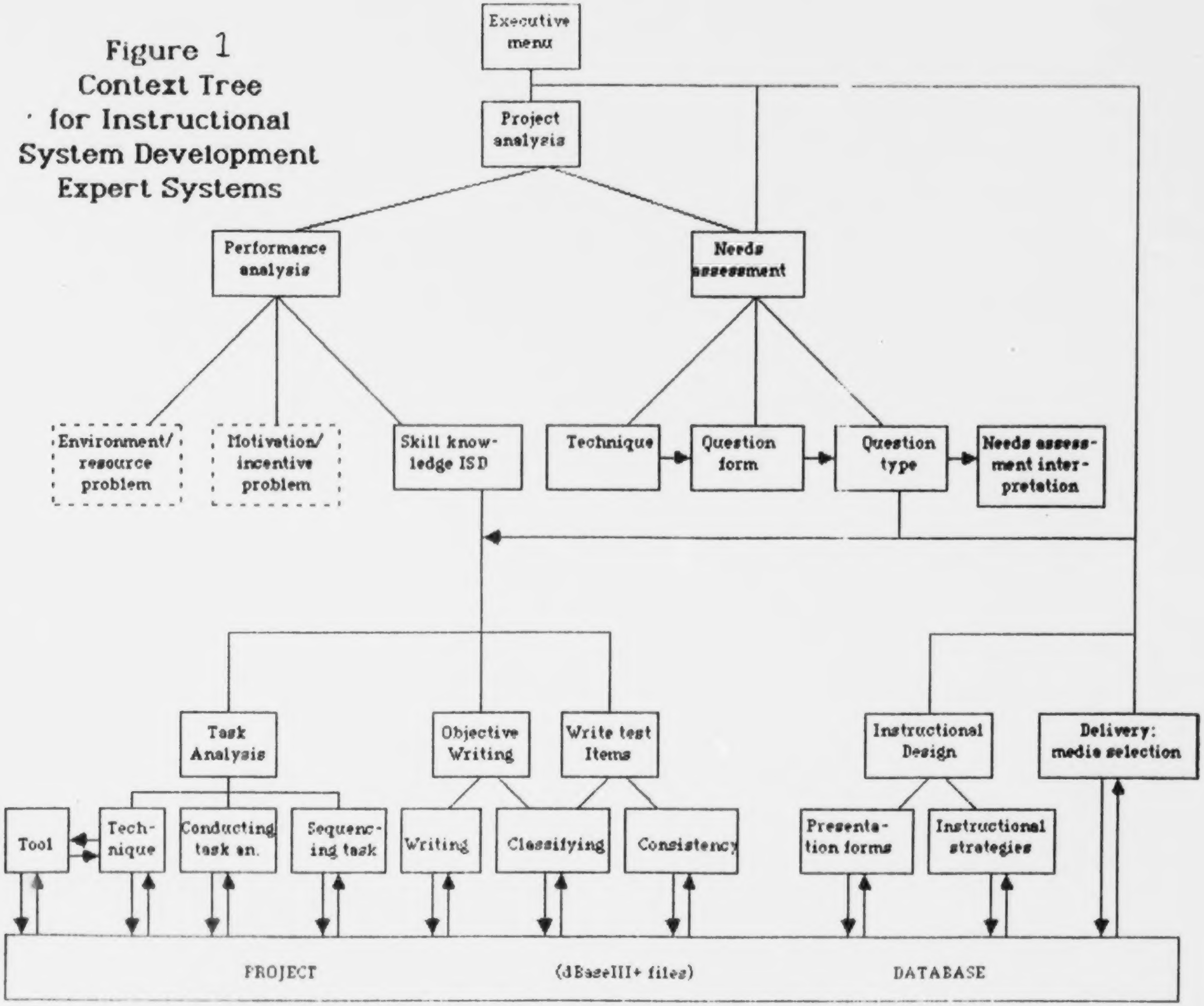
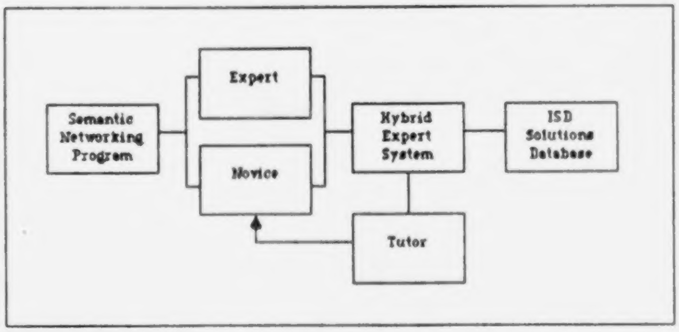

Executive menu
Project analysis
Performance analysis
Needs assessment
Environment/ resource problem
Motivation/ incentive problem
Skill knowledge ISD
Technique
Question form
Question type
Needs assessment interpretation
Task Analysis
Objective Writing
Write test Items
Instructional Design
Delivery: media selection
Tool
Technique
Conducting task an.
Sequencing task
Writing
Classifying
Consistency
Presentation forms
Instructional strategies
PROJECT (dBaseIII+ files) DATABASE

**Figure 2**
**Rules for Selecting Task Analysis Techniques**

```
IF        Type-Job AND
          Scope-Single AND
          Function-Sequence AND
          Cost_Time-Low AND
          Expertise-High
THEN      Technique-Learning_Contingency_Analysis;

RULE 12
IF        Type-Job AND
          Scope-Single AND
          Function-Description AND
          Cost_Time-Low AND
          Expertise-Low
THEN      Technique-Behavioral_Analysis;

RULE 13
IF        Type-Job AND
          Scope-Single AND
          Function-Description AND
          Cost_Time-High AND
          Expertise-High
THEN      Technique-Functional_Job_Analysis;

RULE14
IF        Type-Job AND
          Scope-Single AND
          Function-Description AND
          Cost_Time-Low AND
          Expertise-High
THEN      Technique-Learning_Contingency_Analysis;

RULE 15
IF        Type-Job AND
          Scope-Single AND
          Function-Description AND
          Cost_Time-Low AND
          Expertise-Low
THEN      Technique-Methods_Analysis;
```

**Figure 3**
**Components of an**
**ISD Advisor/Instructor**


Expert
Semantic Networking Program
Hybrid Expert System
ISD Solutions Database
Novice
Tutor

# IN SEARCH FOR QUALITY FACTORS:

## **Analogies** from a Review of **Literature** and **Empirical Studies** on the **Production** of **Courseware**

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## ABSTRACT

Nowadays, it is widely accepted that CAL/CBT has benefits and therefore can be used effectively. However, there are still several drawbacks and shortages existing such as the overall **low quality** of the courseware.

Therefore, a study was established with a threefold purpose; one of them encompassed the identification of a **set of quality (assurance) factors** for the **development** of quality courseware.

This paper focusses on the identification of **discriminatory** factors for the **production** of **quality** courseware. The research included literature reviews to draw **analogies** between several fields of knowledge, survey validations, and data of a research trip.

The paper concludes with a **set** of quality factors **helpful** for institutions which recently joined this area or want to improve their production system.

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## 1. INTRODUCTION

### 1.1. Problem: Why is Courseware Still Said to Be Poor?

One of the best documented findings in literature about the **production of courseware** is the **overall low quality** of CAL materials used in education and training. To illustrate, **Sethna** identified more than 20 authors which came up with this finding between 1981 and 1984; **Hirschbuhl** presented interesting empirical results for corporate U.S.A. in 1988.

Why is the **majority** of CAL/CBT materials **developed** for education and training **still** said to be **poor**! Were the principles and methods of **software engineering** and **Instructional Systems Design** (ISD) **not** respected? Or are these principles and methods **not appropriate** for the development of courseware? Moreover, are **specific** methods and instruments needed for courseware development?

These are some questions which, in turn, give rise to many hypotheses to explain the overall poor quality of courseware; most of them focus on the **development** of courseware seen as a **software product** itself, and the **management** of this process.

As a matter of fact, we believe that the **production** of courseware and its **management** contributes to great extent to the **learning effectiveness** of the final product. **Bork** [1984] states that the present basis of comparison of production **systems of courseware is weak, coming from very few empirical studies of different ways to compose courseware. Moreover, the same author mentions that we have little experimental evidence** about how varying the production system affects the courseware produced, and other parameters involved. Although many of the components of the production system can be argued on rational, pedagogical, or economical grounds, it will be desirable to have more than arguments available [Bork, 1984a].

## 1.2. Background of the Study

The low quality of courseware, among other reasons, let me conduct a research study which had a **threefold** purpose, as follows:

1) Identification of a set of **basic instructional factors** for the design and the summative evaluation of courseware;
2) Investigation of production systems and identification of **quality factors** which may make a **difference** between good and poor quality courseware throughout the development of the materials; and
3) Investigation of the **impacts** courseware and student characteristics have upon the learning achievement.

The identification of a set of fundamental instructional factors was carried out in 1986, the investigation of production systems and quality factors in 1987, and the empirical study was conducted in secondary schools level two (= age-bracket between 15 and 20) in Switzerland in 1988.

## 1.3. Definition of Terms

For the purpose of this study, several **definitions** were used for the terms listed:

a) **Courseware**: Many terms and acronyms exist in the area of "computers in education". For my study, it is sufficient to distinguish between the **generic** software product (not especially designed for education and training) and the **subject-specific** software (= **courseware**).

b) **Quality**: This term has **several** meanings depending on the viewpoint:
   - The first view of students, instructors, and data trainers, **learning effectiveness**, means bringing about the desired learning results. For instruction, the results are defined through previously defined instructional objectives or goals. Normally, the learning effectiveness is measured by the achievement and/or the retention within a pre- and post-test design.
   - The second view of decision-makers or evaluators focusses on the **decision-making process** and the **implementation** of courseware in education and training.
   - At last, we consider the view of software engineers. **Software quality** is defined by the **IEEE** offering a selection of four definitions for the term "quality" in software development.

   We believe that the three notions of quality - learning effectiveness, evaluation and management, and software quality - are not independent. For the purpose of this study, the **first** definition and view of quality, the **learning effectiveness**, is **crucial** and therefore will be used synonymously for the term **"quality"**.

c) **Production system**: A courseware production system is the (entire) set of activities beginning with vague ideas about the concepts to be taught and ending with finished materials in the hands of users [Bork, 1984a]. A production system encompasses a production **strategy** and a production **approach** to develop courseware.

d) **Production strategy**: Production strategy means the overall **combination of resources** to set up and run a production process of courseware development. Questions addressed in this context concern decisions about manpower and required skills, hardware and tools used for the development. A well known discussion in this context is the use of authoring languages or systems versus all-purpose high level languages or the team versus individual strategy discussion.

e) **Production approach**: The term production approach encompasses the way and **process** of production and focusses on the application of software engineering and the ISD models to courseware development.

## 1.4. Assumptions

The investigation of the development of courseware is based on a variety of assumptions. The following assumptions are most important:

- The production of quality courseware is a non-trivial process. It requires **skilled** people who know what they do. [Bork, 1984b]
- "Effective ways of producing computer based learning material exist ..." and "no effective shortcuts are available for developing computer based learning material." [Bork, 1984b]
- There is **seldom one** best or single way to develop courseware that suits **everybody** and each **situation** equally well. But there are certain **general** principles that the developer should bear in mind when developing his/her best way.

### 1.5. Method and Remainder

What kind of instruments and methods were used to investigate production systems and quality factors? Table 1 presents the main instruments and methods used for the overall activities throughout the study.

**Table 1:** Main Instruments and Methods Used throughout the Study

| Activities and Procedures | Main Instruments and Methods | | | |
|---|---|---|---|---|
| | Literature Review | Surveys | Research Trip | Empirical Study |
| - Investigation of production systems | X | X | X | |
| - Identification of quality factors | X | | | |
| - Validation of quality factors | | X | X | (X) |

The remainder of this study summarizes **main** results of the study, as follows: **First**, an introduction to the development of software for education and training is given, based on a review of literature (What the **literature** reveals). **Secondly**, the results of two surveys and the soft data of a research trip to the U.S.A. are presented (What **experience** shows). **At last**, the empirical findings are compared to literature and **discussed** in order to identify a set of basic quality factors which may increase the chance of producing quality courseware.

## 2. RESULTS

### 2.1. What the Literature Reveals

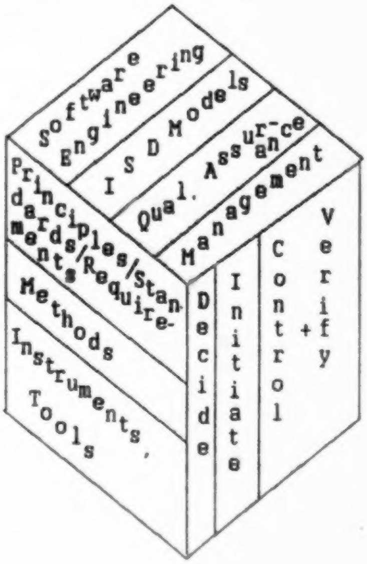
### 2.1.1. Introduction: Where Can Analogies Be Found and Retrieved?

Considering the fact that courseware is both, **software** and **course material** in one product, information may be retrieved and analogies found in ISD, software engineering and related fields of knowledge such as quality assurance, and management sciences. Ill. 1 depicts the main **fields of knowledge** which, in turn, include three levels of **elements** (= principles, methods, and instruments). Again, in each field of knowledge, decisions have to be taken, processes initiated, controlled, and verified as main **functions** within a courseware production system.

### 2.1.2. The Merits and Problems of ISD

The literature review on ISD and the development of courseware materials revealed that ISD models can be used as a **guideline** for the design, development, evaluation and management of instructional materials.

**Ill. 1:** The Courseware Production Cube (= An Overview of Fields of Knowledge, Elements, and Main Functions to Draw Analogies for the Development of Quality Courseware)



The challenge to incorporate such models into reality, while being aware of the **problems** that may occur as outlined by **Romiszowski** and 30 instructional designers in a problem matrix, is still present among education and training professionals. Although not all ISD models prescribe the same procedures, the result of **Andrews** and **Goodson**'s meta-analysis emerged with 14 steps that can be found in almost any model. This let me conclude that some **crucial** tasks seem to exist, such as the instructional analysis or the formative evaluation, which are a **prerequisite** for the development of quality instruction.

**Taylor** and **Ely** established a study to determine whether **publishers of high** quality courseware approach the design and development of courseware **differently** from **other** publishers. The results of the study revealed that a **direct** correlation between the **lack** of systematic ISD models and the **low** quality of courseware **does not** seem to exist; high quality publishers and low quality publishers seem to **meet** the model builders' recommendations on crucial ISD tasks; thus, the ISD tasks cannot be stated as an overall predictor of courseware quality. However, a **major** difference seems to exist between the two groups of publishers in the **overall** development **strategy** (external versus internal developers) and the **attitude** towards the development **process**.

### 2.1.3. Software Engineering and Project Management as a Link to Quality Assurance

The literature review on software engineering revealed that the **life cycle** concept is one of the most important outcomes of this field of knowledge for the time being. **Boehm**, among others, identified **basic principles** of software engineering as prerequisites for software development.

However, software engineering alone cannot guarantee quality software and high productivity. **Related** fields as the **quality assurance** and **management** are necessary. Although, a fair knowledge is available in literature on how to produce quality software, **many problems still exist in reality. Thayer et al.** identified 20 problems in software engineering project management by literature reviews, restated them as hypotheses, and validated them through a widespread survey of 294 individuals. The authors illustrated that in many cases the general principles and methods are **not** respected due to various reasons. Even more interesting is the fact that most respondents suggested more or less **individual** "solutions" to the problems encountered in the development of software. Nevertheless, the authors could **categorize** the vast amount of possible solutions suggested by the respondents into **26** categories!

### 2.1.4. Specific Models and Principles for the Development of Courseware

It is quite interesting that analogies may be drawn between software engineering and ISD models. Ill. 2 describes the overall similarities between a typical ISD model and the software life cycle on a simplified level. On the left-hand side, the main components of a phased ISD model are outlined; on the right-hand side the phased life-cycle of the software engineering discipline is depicted.

**Ill. 2:** Comparison of ISD and the Life-cycle Concept (Software Engineering)

| ISD | Software Engineering |
|---|---|
| 1) **Planning phase:** Including task analysis, statement of objectives | 1) **System definition** and **design phases:** requirements are defined, set and allocated |
| 2) **Development phase:** Creation of the instructional material | 2) **Coding phase:** The design of the system is now coded and implemented on the target system. |
| 3) **Evaluation phase** = formative and summative assessment of the effectiveness of the material | 3) **Test and evaluation phases:** Assessment of the software system |
| | 4) **Maintenance phase:** Corrections/modifications after requirements |

Ill. 2 suggests that ISD and software engineering are two fields of knowledge with strong **similarities** considering the phased models. As ISD models are used for developing "traditional" **instructional** materials, software engineering and the software life cycle is applied for the development of **software** systems. As a matter of fact, courseware development is a reflection and result of **both** - ISD and software engineering.

Moreover, the literature review revealed that more and more **specifie** models and **recommendations** for the development of CAL materials are published. A selection of such models and recommendation lists was reviewd, and a set of quality factors identified.

### 2.1.5. Summary: A List of Suggested Quality Factors for the Development of Courseware Identified from Literature

The literature reviews on ISD, software engineering, quality assurance, project management, and the specific models resulted with several fundamental factors crucial for the development of quality factors. These factors could be **condensed** into a synopsis of suggested factors for the development of **quality courseware** identified from **literature** (see table 2).

## 2.2. What Experience Shows

### 2.2.1. Introduction

Now, the question is how CAL/CBT materials are developed in **reality**. To investigate this question, **two surveys** and a visit of **several production sites** in the U.S.A. were conducted in 1986 and 1987. The remainder of this subchapter summarizes the results of the two surveys and the research trip to the U.S.A.

### 2.2.2. A Follow-up Survey

**Potts** established a study in 1979 to identify and describe factors affecting the **success** of programs in **colleges** and **universities** and to answer the prime question behind the research: What are the factors that contribute **most** to the success of CAI **implementation**?

We **extracted** questions from **Potts's** survey relevant for our research and **added** some further questions to complement the survey. The same fourteen institutions of Higher Education within the U.S.A. were addressed in 1986 as had been done by **Potts** in 1979. This time, the response rate was **50** per cent.

Table 2: Synopsis of Quality Factors for the Development of Quality Courseware Identified from Literature

| Quality Factors | Where Suggested and Identified? | | |
|---|---|---|---|
| | ISD | Software Engineering | Specific Models |
| In relation to the production strategy: | | | |
| - Establish a **team** | | | X |
| - Include an **external SME** in the development | X | | X |
| - **Standardize** the language and the documents | X | X | X |
| - Include a **project management function** into | X | | |
| the development: including **scheduling, budgeting, product control**, | | X | |
| and **accountability for results**, | | X | |
| with the **commitment** to **improve** the process | | X | |
| - Use **modern programming** | | X | |
| practices, such as **prototyping** | | X | X |
| - Use **better** and **fewer** people | | X | |
| - To conclude: Establish an **organizational** structure | | | X |
| In relation to the production approach: | | | |
| - Use a **phased model** | X | X | X |
| - Perform **continuous** validation (reviews, tests, evaluations) | | X | X |

The main results covered the following fields of interest [**Karrer** 1987]:
- Number of persons included in the development (Investigation of team and individual-based strategies);
- Composition of development team;
- ISD and instructional factors; and
- Programming language used.

### 2.2.3. A Survey Focussing on the Development and Use of Courseware

It was the goal of the second questionnaire on the **development** and **use** of courseware conducted in January 1987 to get a **clearer understanding** based on the results of the Follow-up survey outlined in the preceding section. 64 non-profit and profit institutions in England, the Federal Republic of Germany, the Netherlands, Switzerland, and the U.S.A. were addressed.

Seven **profit** organizations out of 42 returned the **survey**; however, only two were **fully completed**! It seems that profit organizations, especially in Europe, do **not** like and/or appreciate surveys about their internal organization and procedures. On the other hand, 11 out of 22 or **50 %** of the **non-profit** organizations returned a completed questionnaire. Thus, the wealth of information gathered cannot be considered as representative, but gives a good impression of the methodology of courseware development.

**Table 3:** Synopsis of Suggested Quality Factors for the Development of Quality Courseware Identified from Empirical Studies

| Suggested and Identified Quality Factors | Where Suggested and Identified? | | |
|---|---|---|---|
| | Follow-up Survey 86 | Survey 1987 | Research Trip 1987 |
| In relation to the production strategy: | | | |
| - Establish a **team**, i.e. include **diverse skills** set in the team (SME, Instr. Designer, Project Manager, Programmer, and so on) | X<br>X | X | X |
| - Use an **external** SME | | | X |
| - **Standardize** (documents) | | | X |
| - Use **prototyping** facilities (as an outcome of modern programming practices) | | | X |
| - Ensure heart and mind commitment of **staff** | | | X |
| - Include a **project management** function (communication, scheduling | | | X |
| - The production **strategy** in general | | X | |
| In relation to the production approach: | | | |
| - **Adapt** an ISD approach; go as far as possible in the initial design | X | | X |
| - **Integrate** the instructional factors in the production approach | X | X | |
| - **Apply** the software life cycle to the development of materials | | X | |
| - Apply an **iterative** process of reviews and evaluations | | X | X |

The main results covered the following fields of interest [**Karrer** 1987a, 1988]:

- Team and individual-based production strategies;
- Authoring courseware;
- ISD models and procedures and instructional factors;
- Evaluation of production approaches;
- Design instruments; and
- Quality factors of courseware development.

### 2.2.4. Results of a Research Trip to the U.S.A.

Based on the results of the two surveys, an in-depth analysis of production systems in operation was conducted in U.S.A. in Spring 1987 to get a better understanding on the **quality** factors. Besides miscellaneous contacts with institutions in the field of CBT and CAL, 15 profit and non-profit **development sites** were visited and investigated.

The results of this trip were established in a report [**Karrer** 1987b] describing the production system of 12 institutions and identifying a set of quality factors.

### 2.2.5. Summary: A List of Suggested Quality Factors for the Development of Courseware Identified from Experience

Table 3 summarizes the suggested quality factors for the development of quality courseware identified from the results of the surveys and the research trip.

The investigated institutions seem to be aware of the establishment of a **team strategy** (including staff with a diverse skills set), the **integration of instructional** factors, and the application of an **iterative** (life cycle) **process** in-

**Table 4:** Comparison of Quality Factors Stated in Literature and Identified from the Results of Empirical Studies

| Suggested Quality Factors | Where Identified? | |
|---|---|---|
| | Literature | Experience |
| In relation to the production strategy: | | |
| - Establish a qualified **team** with a **diverse skills set** (and ensure a heart and mind commitment) | Engineering | X |
| - Use an **external** SME | ISD | U.S.A. 87 |
| - **Standardize** documents and the language used by the developers | ISD/CAL | U.S.A. 87 |
| - **Manage** the **project** (to organize the communication, scheduling, budgeting, product control, and accountability for results with a commitment to improve the process) | X | Survey 87<br>U.S.A. 87 |
| - Use **modern programming practices** (such as prototyping) | Engineering | U.S.A. 87 |
| In relation to the production approach: | | |
| - Use a **phased model** (adapting the crucial tasks of ISD and the software life cycle) | ISD/ Engineering | U.S.A. 87 |
| - Use the **instructional factors** throughout the development | (ISD) | X |
| - Apply an **iterative** process (and perform **continuous validations** with reviews and evaluations) | X | X |

Annotations:

1) X = suggested from all or most sources (of literature or empirical studies)
2) The terms "Engineering", "ISD", "CAL", "Potts", "Survey 87", and "U.S.A. 87" represent the specific sources from which the factor mainly was identified or suggested.

cluding **reviews** and **evaluations** after **each** developmental step as **accepted** and **well known quality factors** which may discriminate between good and poor courseware.

## 2.3. Discussion

Although the constraints, experiences made, overall situations and the production **systems** of courseware in operation are **very diverse**, and although nearly **each** profit or non-profit courseware developer applies the **ISD** procedures **differently**, it was possible to identify two lists of **basic** quality factors (identified from literature and the empirical findings) which may discriminate between good and poor quality courseware. Table 4 gives an **overview** of the suggested quality factors and the sources of their origin (literature-based or experience-based).

Table 4 reveals that **all** quality factors are supported by both **literature** and **empirical** results! Some of the factors were originally identified by the field of ISD, others by software engineering. This confirms again that the development of courseware has to be co-operation in **software engineering** and ISD.

## 3. SUMMARY and CONCLUSIONS

Two sets of quality factors were presented, identified from **literature** and suggested by the **empirical** results. These two sets were **compared** and **integrated** to get a **final** list of quality factors. To **conclude** and **answer** the three introductory questions, it has been shown that the principles of software engineering are often **not** respected in software development. Moreover, investigations revealed that software engineering **alone does not** cover the whole field of courseware development; ISD principles and tasks also have to be included. The set of basic quality factors represents this finding.

It was stated in the introductory chapter that "the present basis of comparison of production systems is weak, coming from very few empirical studies of different ways to compose computer-based material" [Bork 1984]. What has been produced here is an **approach** of using **analogy and synthesis** to **condense as much** information as **possible** from **literature** and **empirical studies** with the goal to identify a set of **basic** quality factors. In this sense, the set of basic quality factors is a **small step** in the **comparison** of production systems giving **directions** helpful for those institutions which recently **joined** this area and/or want to check and **improve** their production system.

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# A Prototype Research Reference Interface for Knowledge Based Instructional Design Systems [1]

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ABSTRACT

This paper describes the design and development of a demonstration prototype Research Reference Interface (RRI) designed to justify, explain, and elaborate instructional design decisions in knowledge based instructional design systems. RRI uses ID Expert, an instructional design expert system, as the basis for providing explanations of instructional design prescriptions. However, the methodologies used in developing RRI can be generalized to other systems as well.

## Introduction

With the advances in Artificial Intelligence research, especially in the development of expert systems, there is a growing interests in designing expert systems to assist instructional designers in doing their job (Gayeski, 1989).

One example of such a system is ID Expert (Merrill & Li, 1989). ID Expert is an instructional design expert system which assists instructional designers and developers in instructional design decision making. It guides an instructional designer through content analysis, sequences the instruction based on the information gathered during the content analysis, and recommends which instructional strategies are best to teach the content. During the consultation, the instructional designer may query the system on the underlying reasoning process. Although ID Expert demonstrated its capability in explaining its line of reasoning to the designer, the explanation is restricted to a direct translation of the decision rules represented in the system. This approach can be found in most existing expert systems, and become one of the standard features of many expert system building languages (shells).

The effectiveness of this kind of explanation is questionable because it lacks on-line support of a robust description of the rationale for its decision. A robust rationale would include both guidelines and research references as justification in instructional design and development. Therefore, adding a Research Reference Interface (RRI) to a knowledge based instructional design system is important from the perspective of increasing users' acceptance of the system. The purpose of this paper is to describe the design and the implementation of the Research Reference Interface.

## Project Strategy

To demonstate the feasibility and functionality of RRI, ID Expert was selected as the basis for providing justification, explanation, and elaboration of instructional design prescriptions. The fundamental concept of RRI implementation involves concatenating a set of rules common to both ID Expert's knowledge base (Merrill & Li, 1988) and a domain-independent rule set of instructional design and delivery rule (O'Neil, Slawson, & Baker, 1987). O'Neil et al. (1987) generated a set of domain independent and domain dependent instructional strategies, represented in production rule form, in troubleshooting an electronic sub-system of a weapon system. RRI uses the domain-independent rules to justify, explain, and elaborate the prescriptions of ID Expert. This rule set was: a) derived from the literature in educational psychology and training as well as intelligent tutoring systems (ITS); and b) elicited from interactions with M. David Merrill and R. M. Gagne.

Initial analysis of ID Expert's knowledge base and the domain-independent rule set revealed only a few common rules, defined as the common rule set. The minimum overlap is a result of a major conceptual difference in focus between the two projects--i.e., instructional design (ID Expert) vs. instructional delivery (domain-independent rule set)-- and the fact that both projects are at the proof-of-concept prototype stage and, thus, are of necessity focused and thus, incomplete. To insure a robust demonstration prototype of RRI, additional rules from ID Expert's knowledge base (Merrill & Li, 1988) were added to the common rule set as the basis for explanation and elaboration.

## Identifying What To Be Explained

A common form of knowledge representation in expert systems is in terms of production rules. A production rule takes the form of an IF-THEN statement. The IF-part is often referred to as the premise, and the THEN-part is the conclusion. The conclusion may be derived only if all the conditions specified in the IF-part are true. Figure 1 shows an example of production rules from ID Expert's knowledge base.

One may already noticed that such a rule is not easy comprehensible. Some form of transformation of the rule is in order. This section discusses three types of transformation methods: translation, conceptualization, and decomposition.

### Translation

Translation is the most simple form of transformation. The goal of translation is to filter out those elements of a rule that are dependent to the knowledge representation tool used, and present the rule to the use/designer in plain English. In most cases the knowledge engineer(s) of the expert system may already have a knowledge engineering document that documents the rule in plain English. Then, it can be directly used to present the rule to the user. Figure 2 is an example of the translated rule in figure 1.

### Conceptualization

The knowledge base of an instructional design expert system contains the knowledge that represent the problem solving skills of an expert instructional designer. A large portion of such knowledge is heuristic based. The factors that the expert considers in making a conclusion may not directly include those variables investigated by the researchers in educational psychology, learning theory, instructional design, and other related fields. Thus, there may be a conceptual mis-match between the factors considered by the expert, and the constructs commonly used in the literature. It is not surprising because the expert relies on specific information to make skillful decisions, while the literatures focus on the generality of the variables investigated. The goal of conceptualization is to close this gap, and make the instructional design rules more comprehensible to the practitioners in the field.

For example, in figure 2, the domain expert consider the role of student in making the decision. A review of other rules in the knowledge base indicated that the role of students may take four different values: consumer, supervisor, technician, and problem solver. Though the role of students is a variable seldom mentioned in the instructional designer literature, it may be used to derive the degree of learning required, which is important in instructional design decision making. Then, an intermediate concept, the degree of learning required, is introduced, and results in the rule set illustrated in figure 3. Only the second rule is considered for further explanation and elaboration because the first rule is quite comprehensible and intuitive in nature.

### Decomposition

During an instructional design consultation, the rules that the expert uses frequently contains an integrated set of factors such as in Figure 3. Three variables are either directly or indirectly considered: 1) degree of learning required, 2) familiarization with the content of instruction, and 3) motivation toward learning. The transaction (instructional) strategy recommended is also an integrated one. A review of other rules in the knowledge revealed that each strategy consists of three parts: 1) learner control vs. system control, 2) remediation vs. new presentation of the content, and 3) depth control (learner control over the selection of content) vs. no depth control. The goal of decomposition is to identify the underlying causal relationships investigated by the researchers in the field. Figure 4 listed some examples of such relationships that were used to identify related literature for explanation and elaboration.

### The Prototype RRI

The Prototype RRI was implemented in HyperCard on a Macintosh computer. It consists of three major components: 1) overview, 2) simulated expert system, and 3) browsing. Figure 5 illustrates the functional components of the RRI system.

The "overview" component describes the background and rationale of the Research Reference Interface, an on-line help system regarding how to use RRI, and a system organization map so that the user may quickly jump from one component of the system to the others.

The "simulated expert systems" component simulates the consultation of existing knowledge based instructional design systems that have been interfaced with RRI, and augments the consultation with research references and guidelines. Although the current version contains only a partial simulation of the ID Expert, the system has an "open-end" architecture so that the simulation of other expert systems can be added easily. This component will be further elaborated in next section.

The "browsing" component allows the users to browse the database of RRI in terms of several paths such as instructional strategies, references, or guidelines. The purpose of this component is to make the database of RRI a stand-alone component, and offer the user an effective and efficient way to browse through the instructional design principles currently documented in RRI, and their associated references. Therefore, while each simulated expert system may contain a sub-set of references and guidelines, the browsing component provides the user an integrated database for references and guidelines currently available.

The "instructional strategies" component categorizes the research on instructional strategies. The current available categories are micro-sequencing and macro-sequencing of instruction. However, the system is "open-end" so that research on other categories can be identified, and added on to the system's database.

The "guidelines" component allows a user to browse through all the guidelines in the database of RRI. The guidelines are instructional design principles on which the rules were based. The guidelines were meant to be a rewording of the rules with a high inference comment for an instructional designer. For each guideline, it is identified that whether the guideline is based on research findings or expert opinion. A rating in the form of degree of confidence (high, moderate, and low) is also given as third part justification of the guideline.

The "references" component allows a user to browse through all the references stored in the database. The reference is a citation, in American Psychological Association format, and an abstract of the study supporting the guidelines. The reference card is meant to be a low inference summary of the article. For empirical research, statements are made only if the results section indicated statistical significance.

A reference may generate more than one guideline, and a guideline may be derived from more that one references. Therefore, a cross-reference system was implemented to link the "references" and "guidelines" components of the system. The browsing paths are dynamically configured so that the user may freely and yet quickly traverse through the database. For example, at any reference display, the user may browse through all the guidelines associated with the reference, and vice verse for the guidelines.

### Interface to Knowledge Based Instructional Design Systems

The purpose of RRI is to explain and elaborate the instructional design decisions in knowledge based instructional design systems. Since these systems often are developed in different type of computers (e.g. the version of ID Expert used here was implemented on a VAX computer), a real-time on-line interface demands extensive development effort. The approach taken in RRI is to develop a small scale simulation of the knowledge based instructional design system, but also leave flexibility to integrate RRI with the real systems if they are available on the same platform as RRI. This approach is reflected in the system process diagram depicted in figure 6.

The simulation consists of simulated user input, system recommendation, inference engine, and rule display components. It allows a user to work through a consultation similar to the one with the actual system. However, the simulation is slightly different from the actual operation of the simulated system in the way that the simulated system always works from input to output, while the simulation works both directions. By doing so we decrease the requirements for user input in that it is no longer necessary for a user to specify all the inputs to the system to view the references and guidelines underlying the recommended instructional strategies. In the case of ID Expert, a total of nine (9) instructional strategies are recommended. If the user specifies all the inputs, then the simulated inference engine will try to recommend an instructional strategy based on the inputs. However, if the user specifies only partial or no inputs, either a partial matched or the whole set of instructional strategies will be displayed. The user may then choose one from the list, and view associated references and guidelines for the strategies.

Once the user selects a strategy from the list, related rule(s) will be displayed. The "browsing manager" will dynamically configure a set of guidelines and references associated with the rule(s). The browsing mechanism of RRI is then at work to allow the user browsing through this identified guideline and reference set for the selected instructional strategy.

## Conclusion

This project demonstrated the feasibility of a research reference interface to explain and elaborate the instructional design decisions in knowledge based instructional design systems. Although the prototype RRI uses ID Expert to demonstrate the functionalities of its explanation and elaboration of instructional design decisions, the methodologies used in the analysis of the knowledge base of ID Expert, and the basic design of the system can be generalized to the development of research reference systems for other knowledge based instructional design systems, and on other computer platforms.

A full implementation of the Research Reference Interface, and/or future development of similar systems will not only increase user acceptability of knowledge based instructional design systems, but also facilitate the assimilation of instructional design knowledge, and thus, improve the quality of instruction and training.

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```
DEFINE RULE     PATH.TRANSACTION.004
::APPLIED.TO    t: transaction
::PREMISE     already.existing(c:course | student.role[c] is in (technician, problem.solver)) and
              already.existing(s:student | student.motivation[s] is high) and
              already.existing(m:module | student.familiarization[m] is high)
::CONCLUSION path.transaction[t] = "Rcmedial Learner Control Basic Instruction"
```

Figure 1. A Sample Rule from ID Expert (from Merrill & Li, 1988).

If The role of the students is TECHNICIAN, or PROBLEM SOLVER and
The motivation of the students is HIGH and
The familiarization of the students to the module is either MODERATE or LOW
Then The transaction strategy should be "Remedial Learner Control Basic Instruction"

Figure 2. An Example for Translation.

If The role of the students is TECHNICIAN or PROBLEM SOLVER
Then The degree of learning required is HIGH

If The degree of learning required is HIGH and
The motivation of the students is HIGH and
The familiarization of the students to the module is either MODERATE or LOW
Then The transaction strategy should be "Remedial Learner Control Basic Instruction"

(a) student motivation and the mode of instructional control
high motivation -> learner control
low motivation -> system control

(b) student familiarization vs. the mode of instructional presentation
high familiarization -> remediation
low familiarization -> new presentation

(c) student familiarization vs. the mode of instructional control
high familiarization -> learner control
low familiarization -> system control

[ *ECT. Omitted for rest of the relationships.* ]

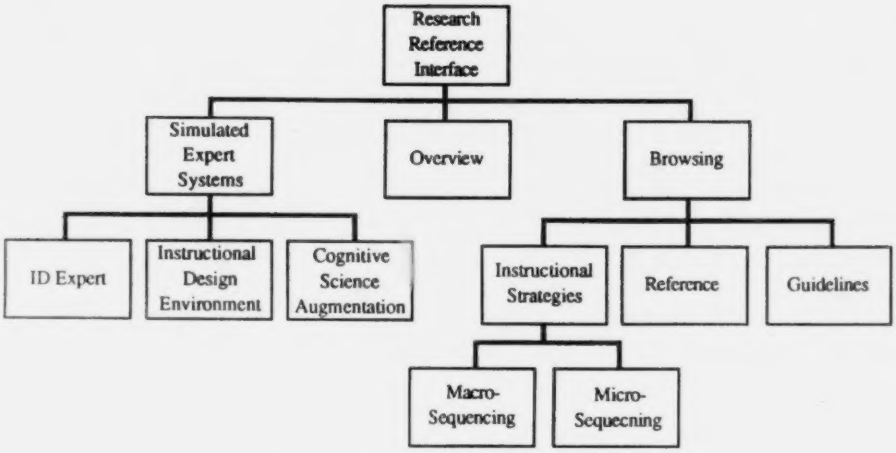
Research Reference Interface
Simulated Expert Systems
Overview
Browsing
ID Expert
Instructional Design Environment
Cognitive Science Augmentation
Instructional Strategies
Reference
Guidelines
Macro-Sequencing
Micro-Sequecning

Figure 5. The Components of RRI.

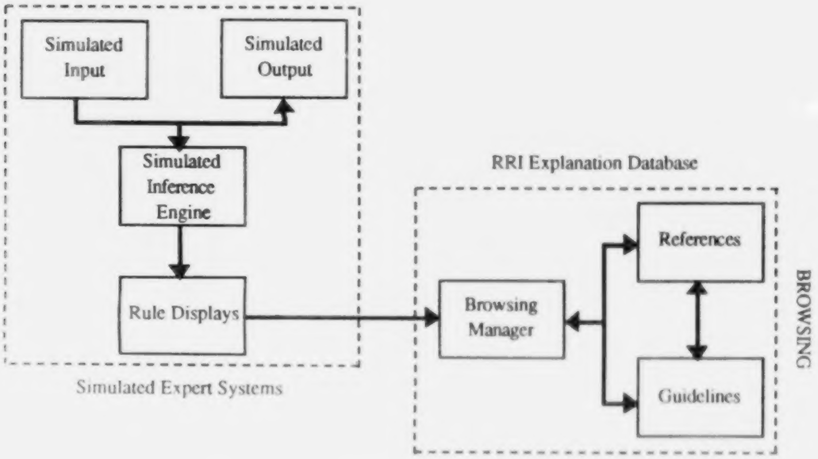
Simulated Input
Simulated Output
Simulated Inference Engine
Rule Displays
Simulated Expert Systems
RRI Explanation Database
Browsing Manager
References
Guidelines
BROWSING

Figure 6. RRI System Processing Configuration.

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# A Review of Instructional Design Expert Systems

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## ABSTRACT

This paper reviews the current status of instructional design expert systems. Existing systems are classified into two major Categories: task-oriented expert systems which support a particular task of instructional design, and process-oriented expert systems which assist in the whole process of instructional design. The different approaches and underlying instructional design models of these systems.

Although two decades of research on instructional design theories have achieved fruitful results for the improvement of instruction, instructional design is still the bottleneck in the instructional system development (ISD) process due to lack of well-trained instructional designers, and lack of adequate tools to assist the instructional design process. Existing ISD models often specify what to do at each phase of instructional design process, but not how to do it (Montague & Wulfeck, 1982). With the development in expert system research, there is a growing interests in developing expert systems to assist instructional designers in doing their job, and thus, provide how to do it knowledge to novice instructional designers. The purpose of this paper is to review the current application of expert systems in instructional system development, and compare and contrast the approaches used in these systems.

An instructional design expert system is a computer program that can solve instructional design problems in ways that skilled instructional designers would solve them. It is constructed using a knowledge engineering approach in which the problems solving expertise of skilled instructional designer(s) are elicited, and represented in a knowledge base of the expert system. It emphasizes the separation of instructional design knowledge from general reasoning strategies used in problem-solving.

There are two categories of instructional design expert systems: task-oriented and process-oriented. The task-oriented instructional design expert systems focus on a specific task of instructional design process such as media selecting or writing instructional objectives. The process-oriented instructional design expert systems deal with the whole process of instructional design. For example, it may start with a goal of instruction, and assist an instructional designer to decide which instructional methods are most suitable to fulfill the goal.

## Task-Oriented Instructional Design Expert Systems

Existing approach to systemize instructional system design is to provide instructional designers with a task list of what to do and When to do it in terms of an ISD model. The purpose of such a model is that by systematically following the steps and procedures suggested in model, quality instructional materials may be produced. However, novice instructional designers do not benefit too much from the model due to its lacking of guidance and assistance on how to perform the tasks or steps suggested in the model. Task-oriented instructional design expert systems supplement the weak spots of ISD models by assisting instructional designers in performing some specific tasks suggested by ISD models such as media selection, and instructional objective preparation.

### Media Selection

Media selection is one of the active area in which the feasibility of using expert systems in solving instructional design problems is explored. It was suggested as an appropriate application of expert system (Grabinger, Wilson, and Jonassen, 1988). The fact that there is a relative large number of existing media selection models provides such an application with a rich knowledge base for knowledge engineering opportunity.

Ruyle (1989) developed a system called Media as an intelligent job aid to assist instructional designers in selecting appropriate media for a given instructional situation. The factors considered in the decision making are the nature of instructional objectives (cognitive, psychomotor, and affective), target population, instructional setting, and etc. The knowledge is represented in production rules argument by mechanism called certainty factor, which indicates how truthful and/or certain is the conclusion generated from the rules.

Wagner and Kang (1989) are undertaking a project to develop a media selection expert system based on Reiser and Gagne's media selection model. The purpose of the project is to evaluate the feasibility of using the system to teach media selection strategies to preservice teachers. The system, developed using MacSmart expert system shell on Macintosh computer, asks a series of YES/NO questions related to the attributes described in Reiser and Gagne's media selection model, and makes recommendation on which media is appropriate to use. Although intended to use the system for training preservice teachers, the field test results indicated that the preservice teachers use the system in "an algorithmic fashion, almost as if it was an electronic 'job-aid'" (p. 6).

### Instructional Objective Preparation

White (1987) developed an expert system to assist trainers and teachers in the preparation of behavioral objectives. The IBM PC based system first helps the user selecting appropriate behavioral objective components, namely condition, criterion, and performance. The verb selected as performance component, is then used as a basis for classifying the objective into a learning level such as knowledge, comprehension, application, analysis, synthesis, and evaluation. The classification is based on a list of 53 action verbs pre-entered into the system. Unfortunately, if the user chooses to use a verb not included in the action verbs list, the system is unable to perform the classification task.

### Discussion

Several observations about the systems described here worth mention. First, there is an existing rich literature base for these systems. Both media selection and instructional objective preparation received considerable attention in the past. Second, the systems either were designed to be a tool, or perceived as a tool to be used in the instructional design process. Finally, the methodology used in building these systems is knowledge engineering from printed materials such as books, references, and manuals rather than from a domain expert as in common expert system development pratice. Although this approach may reduce the time and costs necessary for building expert systems, it can seldom result in the powerful systems that can be used in daily instructional design problem solving. Hayes-Roth, Waterman, and Lenal (1983) described two kinds of expert knowledge as public, and private.

> Public knowledge includes the published definitions, facts, and theories of which textbooks and references in the domain of study are typically composed. But expertise usually involves more than just this public knowledge. Human experts generally possess private knowledge that has not found its way into the published literature. This private knowledge consists largely of rules of thumb that have come to be called heuristics. Heuristics enable the human expert to make educated guesses when necessary, to recognize promising approaches to problems, and to deal effectively with errorful or incomplete data. (p. 4)

A common say ti present a media selection model is through a flowchart to represent the decisions involved (such as in Reiser and Gagne, 1983; Romiszowski, 1981). A flowchart is a visual representation of an algorithm. Therefore, in the process of constructing such a media selection algorithm, valuable heuristic knowledge involved in selecting media are often omitted partly because it is very hard to be aura of internalized skills and strategies used in problem solving. From this perspective, one explanation of why Wagner and Kang's subjects uses their system in an algorithmic fashion is that the underlying knowledge in their expert system is an algorithm based on Reiser and Gagne's media selection model.

## Process-Oriented Instructional Design Expert Systems

While the purpose of task-oriented instructional design expert systems is to support some specific instructional design tasks, the purpose of process-oriented instructional design expert systems is to support the whole ISD process. Two prototype systems are being developed to achieve this goal from different angles. Since such systems may have great impact toward how future instructional products will be developed, more detailed description of the two systems will be presented here.

### Expert CML

Expert CML is a knowledge based computer managed learning (CML) system jointly developed by the Alberta Research Council (ARC) and Computer Based Training Systems Ltd. (CBTS). The purpose of the system is to add instuctional design knowledge to an existing CML system to assist "a curriculum developer in producing online curricula and then monitoring an individual student's progress according to the learning objectives specified within the curricula" (Wipond and Jones, 1988, p. 97).

Figure 1 shows the underlying instructional design model of Expert CML, in which design, development, implementation, and evaluation phases of ISD are coordinated by the centralized computer managed learning system.

As an environment for developing curriculum, Expert CML contains two major categories of assistance: curuculum specification, and instructional objective development. At the curriculum specification level, the system uses top-down refinement approach to organize the curriculum hierarchy: such as course consists of topics, topic consists of subtopics, and then modules, and submodules. The system assumes that the content of the curriculum should be evenly distributed among. Therefore, the size and shape of the hierarchy become two of the estimates of curriculum appropriateness. Since each model consists of basic elements such as resources, evaluation items, and learning activities. They become a measure of completeness of the module.

Expert CML uses the similar approach as White (1987) did in his expert system for writing instructional objectives, and classifying the objectives based on Bloom's cognitive taxonomy. In addition, Expert CML also assists the user to sequence these objectives using embedded taxonomic information.

Another important feature of Expert CML is that the expoert component of the system provides advice only. In most cases, the designer may ignore the advice and solely use the system as a tool "to build curricula in any way desired" (Wipond and Jones, 1988, p. 98). Thus, the system is flexible in one sense, but at the expanse of quality control of developed curricula.

### ID Expert

ID Expert is a prototype instructional design expert system which can guide and assist instructional designers through the instructional design process. Figure 2 depicts the instructional design model underlying ID Expert. The basic components of the system is module, which is the primary unit instruction consisting of three standard components: 1) the content representation of instructional materials; 2) a set of transactions which enables the student to interact with the content representation; and 3) a set of control strategies that determine what is the next transaction, and when such a transaction should be invoked during instruction (Merrill and Li, 1989). The instructional design process is then materialized in ID Expert as Module identification, module organization, and module design.

ID Expert assumes that the user/designer has performed a needs assesment and task analysis beforehand so that the specific goals of instruction are ready prior to the consultation with the system. For a given goal, the system gathers information from the user/designer and to recommend what is the appropriate content structure for the goal. It then guides the user/designer through a structured content analysis and elaboration based on the recommended content structure. Once the content structure is elaborated, ID Expert parses it to generate the course organization, in which subject matter contents are grouped into modules as the basic components, and corresponding instructional objectives for each module are recommended. For each module, the system then assists the user/designer to determine what is the instructional functions that the module should have, and what are the instructional transactions that are appropriate for teaching the module content. Further, the system helps the user/designer to determine some of important instructional design attributes for each of the transactions. In the future, ID Expert will allow a user/designer to design and deliver on-line instructional meterials.

The output of a consultation with ID Expert is an instructional design specification which consists of elaborated content structure, and course organization. The course organization specification not only contains the sequence of modules within the structure, but also detailed design specification for each module such as the instructional content and objective of the module, the instructional functions that the module serves, and instructional transactions appropriate for fulfilling the module function, and detailed design attributes for the module.

### Discussion

Process-oriented instructional design expert systems take longer time to develop (both systems reviwed here had been in prototype stage for two years),and usually indicate a joint effort of researchers and developers from both instructional design and artificial intelligence (AI) fields. Due to the complexities involved, they are developed on high-end expert system shells, and more powerful computers (e.g. ART and Common Lisp on Symbolic workstation for Expert CML, and S.1 on VAX for ID Expert) before being ported to the less powerful delivery computers (e.g. VAX, and Macintosh, respectively).

A significant difference between the two systems is their treatment of subject matter knowledge. Expert CML considers the macro-sequencing of subject matter topics an instructional designer's task, offers a flexible curriculum framework for the designer to organize the curriculum, and knows little about the structure of the subject matter topics except their locations in the curriculum structure. In contrast, ID Expert tries to acquire structual information about the subject matter at the content analysis phase of the design, and uses these information to derive the organization of subject matter topics. This difference also affects the treatment of instructional objectives in two systems. Expert CML helps a designer in writing and classifying objectives, while ID Expert generates them for each topic based on the subject matter knowledge acquired. In a sense, Expert CML approach focuses on the flexibility for experienced instuctional designers, and ID Expert focuses on the guidance for novice instructional designers in designing computer based instructional materials.

## Summary

Expert systems have demonstrated feasibility in their application to instructional design. However, several issues need to be resolved. For task-oriented systems, there is an inadequate effort of knowledge engineering in the development process. More researches and developments are needed to extend the applications beyond media selection level. For process-oriented systems, the bottleneck is the insufficient, and lack of specifics of instructional design knowledge to warrant the speedy development of such systems. Different approaches toward instructional design affect the assistance and guidance these system provide. However, how to consolidate the differences among instructional design theories and models is still a unsolved problem.

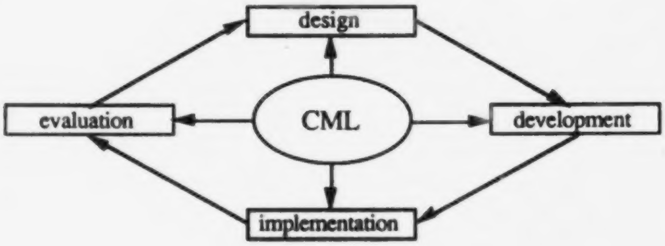

Figure 1. Instructional Design Model of Expert CML

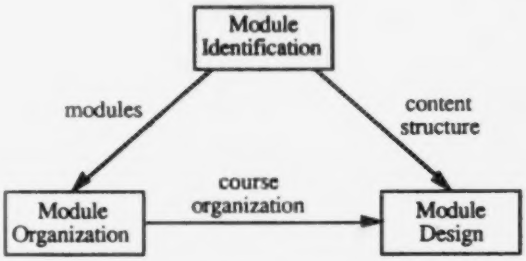

Figure 2. Instructional Design Model for ID Expert

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# An Object Oriented Learning System : G

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G is a Computer Aided Learning System based on several concepts of Artificial Intelligence. Version 1 was presented in 1986. Version 2 is now available with new types of objects: knowledge units, teaching strategies, student's beliefs, etc. The learner model is the key of the system: G build the model dynamically using fuzzy values. New features include the "G-texts".

## 1. CBI and ITS

Recent research in teaching and computer science alike has shown that it is necessary to distinguish between "Computer based instruction" (CBI) and "Intelligent Tutoring Systems" (ITS). We shall use "CBI" and "ITS" while we prefer the term "apprenticeship" to "tutoring" or even "learning", because it evokes the complementary roles of both the learner (or apprentice) and the author (or master).

CBI, over the last few years, has seen the development of coursewares that involve remarkably sophisticated "screens". These are certainly much more elaborate than what most of our intelligent systems have to offer. It can indeed be said that author systems and languages are above all tools for graphic and textual representations.

The "scenario" or "screen" sequence (more or less flexible according to systems) is determined by the learner's answers to the questions produced by the courseware. These answers must be formulated in a certain manner. The learner has very little leeway ("selection" is more accurate than "answer"), except in a few systems that require long preparation by the author of anticipated or probable answers (supposing that no grammatical or spelling errors are made). This type of system can require 150 hours of work by specialized personnel per hour of dialogue.

ITS, on the other hand, lays less stress on screen appearance than on screen content. Development of this content is a dynamic process. ITS attempts to manage and organize knowledge and is based on teaching strategies. Tools for creating a courseware include few or no instructions for screen management but do contain "instructions" (actually replaced by fields to fill in on a full-page screen) describing pedagogical functions (for instance: prerequisites, objectives, strategies...).

In an ITS system, there is true dialogue: the learner expresses his/her thoughts on a par with the system, asks questions, etc..The exchange takes place in natural language with acceptance of grammatical or spelling errors. Two extreme cases can be considered: either the initiative can be left entirely to the courseware, which operates by asking the learner questions (this is much like the classical CBI approach), or on the contrary, the learner explores the material to be learned by asking questions (this resembles an intelligent documentary system). Our experience has shown that an intelligent courseware must combine both approaches while giving the greater weight to the learner's activity.

There is no place here for a pre-programmed scenario. Instead, the system will use a -dynamically constructed- cognitive model of the learner to generate the sequence of the true dialogue "on the spot".

## 2. Contributions of Artificial Intelligence

We believe that the difference between CBI and ITS does not lie so much in the techniques used to build the software as in the orientation chosen to develop a courseware: will the courseware be "screens-questions-selection-scenario" -oriented or "knowledge-strategies-reflection-dialogue-learner model" -oriented? Naturally, computer methods have their importance and it will come as no surprise that CBI uses algorithmic methods to answer the learner's selections whereas ITS uses A.I. concepts to answer his/her reflections.

Just as CBI has progressed by stages (use of programming languages, then author languages and finally author systems), ITS is likewise not a monolithic entity. Alongside most other ITS, made with classical A.I. tools, system G integrates A.I. concepts without being an expert in the field to be learned. Just like the "author systems" of classical CBI, system G is a "shell", pre-equipped with pedagogical expertise. It will be up to the author to fill the shell with field-related knowledge and aptitudes and with whatever strategies and teaching procedures he/she may deem appropriate.

G, as such, is not an expert system. It can be used, however, to generate potentially intelligent coursewares. G does not give definite solutions to problems but coursewares created under G can, for instance, manage case studies.

G is a system for creating coursewares and a learning and training system that borrows several concepts from A.I., shares some of its techniques and meets some of its ambitions.

## 3. Pedagogical hypotheses

### 3.1. About apprenticeship

When "teaching" and "computer" are united in a system, the resulting educational product should not only supply statements and the possibility of checking or testing, as do most CBI systems. Doubt, learning through mistakes, questioning, exploring, assistance are essential features of the learning process that should not be neglected.

Fruitful dialogue is born when the learner's explorations are met by the teacher's help.

### 3.2. Modelling the learning process

Three types of models must be built in order to automate the learning process:

- a model of content, that is, of the subject matter to be learned, examples, hypothetical events (for a case study), summaries and -last but not least- skills and know-how.

- a model of the pedagogy to be used, that is of teaching methods (statements, examples, questions), of reactions to anticipated learner comments, evaluations, etc. and especially, teaching strategies (answer a question, give an example, illustrate before or after demonstrating, etc.)

- a model of the learner, that is, not only the usual record of the learner's path through the subject matter, but also a model of his/ her cognitive state with respect to this matter and to the teaching strategy used. This flexible, dynamically constructed model, which is not predetermined, will be detailed later in this text.

G, which makes it possible to shape these various concepts into a single bank of procedural objects of various types (or even hybrid objects), resembles other ITS systems in that it makes a distinction between the content to be taught and the pedagogy to be used.

G differs, however, from other ITS systems: the structure of the knowledge bank does not reflect the characteristics of the subject matter itself. Rather, it reflects pedagogical relationships between "objects" used to describe this matter.

### 3.3 The knowledge model

At the beginning, the knowledge to be communicated can be represented as a series of mutually independent objects, like the various entries in an encyclopedia. It can further be said that the qualities required of an author using G are the same as those required of the writer of encyclopedia headings: the headings must keep their meaning regardless of the order in which they are read. To give a clear picture, let us simplify by saying at this stage that each object of knowledge is a sentence.

At a second stage, it is necessary to establish relationships between these objects with the future learner model in mind. When the learner encounters the sentence contained in the object, during his/her session with the computer, this encounter will affect:

- the level of assimilation (the level is a continuous measurement between 0% and 100%) of the idea contained in the object and also possibly of ideas contained in other objects. When a theorem is enunciated, this will improve the learner's level of assimilation of this theorem. When an example related to the theorem is displayed, it can constitute another object that will act to reinforce the level of assimilation of the theorem in the learner model.

- the level (also, a continuous measurement between 0 and 100%) of object pertinence. This is the benefit to be gained by the learner from knowing the object better. It applies also, and most importantly, to other objects that have a pedagogical relationship with the first. Here again there is an analogy with the "see also" suggestions of an encyclopedia.

At a third stage, finally, the descriptive objects of knowledge are linked together by probable or possible pathways of learner exploration. Thus, object B could be an appropriate answer to a student who would ask question Q in the context of object A. This touches upon the various ways to access a heading. Here, of course, the courseware exceeds the capacities of an encyclopedia.

### 3.4. The pedagogical model

Once the model of the knowledge to be learned has been partially or completely established, it is time to consider the teaching procedures to be used for communicating knowledge when the learner's explorations do not suffice.

This pedagogical intervention can take on the form of a statement, a reminder followed by a summary, an evaluation, a question, a reaction to an anticipated question following another question, etc.

Any pedagogical intervention implies that the author is applying one of his/her teaching strategies. G asks the author to define this strategy. The actual choice of a type of intervention will depend for a large part on the current value of the associated strategy's pertinence in the learner model.

The network of pedagogical interventions rests on the network of knowledge objects. On one hand, a reaction, a summary, or even a question supplied by the courseware requires a change in the learner model, in terms of assimilation or pertinence.

On the other hand, whether or not a given pedagogical intervention actually takes place depends on weighting -that makes the possibility more or less plausible- and on the fulfilment of certain conditions. G evaluates this weighting and these conditions, taking into account the levels of pertinence and assimilation in the learner model.

The question-type intervention is the simplest example. Its weight will depend, among others, on the pertinence of the corresponding "strategy" and on the pertinence of the knowledge (objectives) that the dialogue in progress is supposed to further. The conditions concern the minimum level of assimilation that must be attained for certain pieces of knowledge (prerequisites) and the minimum pertinence level that must be reached for certain objectives.

### 3.5 The learner model

The learner model must represent, as faithfully as possible, the history of successive sessions and above all it must reflect the supposed current state of the learner's knowledge and the current state of his/her expressed or supposed wishes.

The model can have an initial state, corresponding to a class of learners. Each learner is unique and very rapidly the different learner models will diverge. We believe it is unnecessary to have them tend towards a single final state in the image of the author or teacher.

In earlier work, we had considered a strictly Boolean model: the learner had or hadn't received a message.

Reflection and experience have revealed the wealth of a fuzzy, three-dimensional model.

It is three-dimensional because it includes:

- for each object (of any type) that makes up the courseware

-a level of assimilation and experience,-

-a level of pertinence, that is a weight to be given an object in view of its possible (re)appearance.

It is fuzzy because the levels of assimilation and pertinence are graded values between 0 and 100 points.

The specificity of each learner model -in conjunction with judicious use of chance- leads to an infinite variety of dynamically constructed scenarios.

### 3.6. dialogue quality

As concerns its content, natural dialogue is not necessarily a perfect dialogue. It is imperative at least that all successive elements be plausible.

As for its form, the student's comments must be typed in English (or French ...) which may contain spelling or syntax errors.

Under G, the system-learner dialogue is a succession of interventions selected in the courseware and prompting's intended to trigger student reactions (answers, questions, comments).

The result is a rather simple (scroll-type) screen presentation of the machine-learner dialogue, in contrast with the considerably more sophisticated interfaces that G makes available to the author: control panels, full-page screens, editors, etc.

### 3.7. The confrontation with reality

Because it eliminates the pre-established scenario and replaces it with a dynamic sequence, the system must be able to handle all aspects of real situations. This includes doubts, approximations, multiple solutions or the absence of solutions, the risk of loops and absurd repetitions, etc.

This will often lead the author to use somewhat arbitrary weighting. A condition of this type could be used: "if the learner writes something that resembles: 'kinetic energy'".

This also leads to rapid divergence in the dialogues of two learners working side by side and giving identical answers...

## 4. The courseware

A courseware developed under G is essentially a set of objects (numbered by the system or manually).

These objects can be changed, edited, printed, etc. independently, which allows creation of the courseware by several people (for instance, an expert and pedagogues) or in several stages. A courseware will improve in the course of time by incorporating new ideas or techniques.

Full-page screens that the author only has to fill in make it possible to create a dozen different types of objects. Use of a "language" for describing objects makes it possible to create any new type of object, so that use of G is not necessarily limited by the educational views of its author.

Several types of objects, with pedagogical specificities, have been added in G version 2. Types now include:

- information or knowledge unit
- learner skill
- learner belief
- syntheses (of informations and knowledge)
- teaching strategies
- teaching acts or tools
- reactions (to learner's answers or questions)
- pedagogical evaluations
- lessons (or sub-coursewares)
- author mail box
- record of the learner model (for a next session)
- etc ...

A detailed list of the uses of all of these types of objects would take up too much space.

## 5. The G object

Each G object has a triple definition.

5.1. The "internal definition" is the actual sequence of events that will be triggered if the object is chosen. This definition, supplied by the author by use of a full-page screen or instructions, contains the description of two distinct types of actions:

- those which have an effect that can be seen on the screen or deduced from what appears on it, for instance text display, execution of a DOS command, clearing the screen, waiting for a certain time to elapse, etc;

One of the most important feature added in version 2 of G is the opportunity to provide a "G-text" (see 5.4 below)

- those which, on the other hand, act to change the learner model as it relates to the object itself or to other objects.

5.2. The "external definition" expresses the rule or rules that eventually trigger the object's presentation. The author defines each of these rules using a full-page screen.

The author describes, for each rule:

- the context in which the rule applies;
- how the rule's weight is to be calculated at a given time (using a few parameters and the pertinence level of a few objects);
- the conditions that must be fulfilled, imperatively or at a certain rate (another concept of fuzzy logic), in order for the rule to be chosen.

These conditions, presented in a friendly form, concern, notably, the learner model and the learner's last statement.

This resembles any natural dialogue in which the sequence of statements depends on the context, on the last statement of the interlocutor and on the image that one has of him/her.

5.3. The third part of an object's definition is the "dynamic" definition, that is the recorded trace, on one hand, of everything that has led the learner to this object and, on the other hand, of all directions that the learner has followed from this object on.

This dynamic definition is a precious tool during a courseware's experimental stage.

5.4 G-texts are created by the author with his/her favourite word processor, eventually using existing unstructured materials.

Data structure is then specified in a natural way.

The learner will have the opportunity to "travel" in the domain using keyboard keys and/or cursor or mouse.

G-texts are used in many pedagogical different situations, varying from multiple choice drill to an approach of the domain in a "Hypertext" style.

But, G is much more than just an intelligent questioning or documentation system: because (a) G-texts are merged within the dialogue with other types of objects, (b) all objects (including G-texts and external procedures) participates in the (dynamically built) model.

### 6. Working modes

Most author systems exist in the author mode but later deliver a compiled form of the learner sequence that can be operated independently. Unlike these systems, G exists in both the author mode and the learner mode.

#### 6.1 In the author mode

The author's essential task is to manage the bank of objects that make up the courseware he/she has created. All edit, create, copy, modify and print functions that one would expect to find in such a system are present.

Two additional possibilities are worth mentioning:

- It is possible to test conditions related to learner statements immediately. This may well be necessary when working with conditions such as the following: "if the answer, interpreted with maximal tolerance of spelling, contains an expression that bears 70% resemblance to 'the ship is in port'".
- It is also possible to simulate a learner sequence, asking G to justify the applied rules and to enable the author to change these rules and the associated conditions.

The author has other, less usual tasks such as managing the morphological natural language analyser or determining values for the many parameters that come into play as a course progresses. May we reassure the reader: G's default values are sufficient for most applications. Nevertheless, the fact that these values can be adjusted makes G a powerful tool for educational research.

In the author mode, the man-machine interface includes principally:

- Control panels: G presents the user with a kind of menu that lists a selection of parameters that can most often be changed by moving the cursor; control panels include on-line help.
- full-page screens: these appear as an amply commented fill-in form.
- the text editor: this editor is very complete but can be replaced by the user's favourite editor or word processing software; this is also a clever way to retrieve data that have already been recorded in another system.

#### 6.2. G in the learner mode

G's most interesting function appears in the learner mode. The dialogue carries on in three stages:

- Once an object has been chosen, G organizes its unravelling: the "visible" actions are carried out, using DOS temporarily where required;

the learner model is updated according to instructions described in the object and to the parameter values.

- In nearly all cases, the learner is invited to react and his/her reaction is interpreted immediately by the morphological analyser.
- G considers the learner's answer (this "answer" can equally be a question...), the context (that is the last object examined and the previous ones), the learner model, the display sequence's current parameters, G's inherent pedagogical rules, for instance, once a learner has asked a question,the system cannot leave it permanently unanswered...),and of course the set of rules that the author has incorporated into the external definitions of objects.

In this way, G selects a new, "most plausible" object.

#### 6.3. Other functions

G presents other functions that it would take too long to describe: the keyboard can be redesigned, the function keys and CTRL key can be used, the analyser, the sets of instructions, the text editor can all be redesigned, there is on-line access to the documentation and to the description of all 500 parameters, etc.

### 7. The morphological analyser

Other publications will describe the morphological analyser in detail. To avoid any misunderstanding, let it be clear that G does not contain a syntactic or semantic analyser and that the technique used is more like "pattern matching".

Beginning with a sentence (the learner's or a target sentence devised by the author), G generates a certain number of numerical "identifiers", which together constitute the sentence's "signature", in terms of words and word order. One word produces several identifiers. The skill (and the danger!)

consists in generating, among these *identifiers*, *identical* identifiers for morphologically similar words.

The originality of this approach is double: on one hand, the analyser will handle differences in spelling with a tolerance that can be varied at will, and on the other hand the comparison of two sentences becomes a simple comparison of two sets of identifiers, which is simple and thus processed automatically by G without any bother for the author.

## 8. Conclusions

The author who leaves aside scenario programming and screen management and turns to G will define objects and come to grips with educational concepts and strategies. The author must accept the fact that he/she is no longer master of the learner-mode sequence and will be surprised, sometimes amazed, often interested by the unexpected turns the dialogue will take.

For the learner, the work session becomes a voyage through the subject matter. He or she is free to create this voyage but a guide is there to help each time the learner hesitates.

G operates on 80286 and 80386 compatibles in the MS.DOS environment.

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# THE EFFECTS OF COMPUTER ANIMATION ON INTENTIONAL AND INCIDENTAL LEARNING AND MOTIVATION

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## ABSTRACT

The effects of animated presentations on intentional and incidental learning was studied. Also studied was the degree to which computer practice activities contained intrinsically motivating characteristics as measured by continuing motivation. A total of 70 fourth graders participated in an introductory lesson on Newton's Laws of Motion. Two levels of Visual Presentation (Static Graphic, Animated Graphic) were crossed with two levels of Practice Order (Questions/Simulation, Simulation/Questions). Within-subjects factors consisted of Learning Intent (Intentional, Incidental), Visual Testing Format (All Verbal, Verbal/Visual), and Test Interval (Immediate, Delayed). Results showed that Animated Graphics successfully promoted incidental learning. In addition, students overwhelmingly chose to return to the structured simulation practice when placed in a free-choice situation.

## INTRODUCTION

Recent advances in authoring computer-based instruction (CBI) have provided designers with relatively easy means of adding diverse and elaborative features to instructional software. Features which once demanded advanced programming skills and liberal development time-lines can now be almost casually incorporated. Animation has long been a popular feature in CBI, and its use, along with other types of graphics, is often encouraged (Bork, 1981; Caldwell, 1980). Unfortunately, animation is frequently added to CBI without serious concern for its true instructional purpose or impact.

Instructional research has focused on two fundamental applications of animation in CBI: 1) animation as a presentation strategy; and 2) practice activities involving interactive animated graphics. Recent reports have offered encouraging results for both applications (Rieber, in press-b; Rieber, Boyce, & Assad, in press). Efficacy of animated presentations appears particularly dependent on task requirements, cognitive load, and attention-gaining devices. In addition to gains on intentional learning, Rieber (in press-b) reported initial evidence of animation's role in contributing to incidental learning. Elementary school students demonstrated modest success in attending to incidental information contained in a single animated display. A need exists to validate this preliminary finding and investigate its implications further.

The study of incidental learning is well established (Ackerman, 1985; Goldberg, 1974; Klauer, 1984; Lane, 1980; Sagaria & Di Vesta, 1978). Past research has primarily focused on interactions between text processing activities, such as pre- and post-questions, and intentional and incidental learning. The search for true "mathemagenic" activities, or activities which give "birth" to learning in general (Rothkopf, 1966), has led researchers to understand that most instructional activities incur tradeoffs between intentional and incidental learning — contributions to one generally impedes the other. Most of this research has concentrated on learning from prose, although several imagery studies have been reported which indicate that recall of incidental information is more robust for pictures than for words (Ghatala & Levin, 1981). Traditional CBI design, based on systems approaches (see Reigeluth, 1983 for a review), has only been concerned with intentional learning, that is, the extent to which predetermined learning objectives have been mastered. Unfortunately, this approach can also lead to instructional designs which are unnecessarily self-limiting and restricting. This design approach is apt to assign a passive role to the learner. The ability of the learner to elaborate upon instruction as well as induce rules and principles not intentionally taught is usually overlooked or ignored. An objective of this study was to investigate whether students would be able attend to incidental information contained in animated visuals and induce a resulting physical science principle from this information without sacrificing intentional learning.

Previous research has demonstrated that animated presentations interact with the practice activities provided in CBI. Traditional CBI has used questioning strategies as successful practice activities (eg. Hannafin, Phillips, & Tripp, 1986). Rieber (in press-b) and Rieber, Boyce, and Assad (in press) compared the effects of questioning strategies to structured simulations as practice activities in science instruction. The structured simulations consisted of animated graphics which obeyed the laws of motion and were under student control. Brown (1983) has termed these applications of animated graphics as "interactive dynamics". The graphics change continuously over time depending on student input, thus acting as a form of instantaneous feedback (Reed, 1985). Adult performance compared equally with both forms of practice, while elementary school children performed best given the experiences with the interactive dynamics. It is speculated that the success of the interactive dynamics with children was due in part to the apparent intrinsic motivational appeal of the simulation — students were encouraged to fantasize about being the pilot of a starship in outerspace. Intrinsically motivating instruction relies on student-driven strategies, rather than external lesson reinforcement (Lepper, 1985; Malone, 1981). Theories concerning intrinsically motivating instruction are based on motivation research which suggests that students who see themselves in control of their success are destined to stay-on task longer in more meaningful ways and are more likely to return to the instructional task given the freedom to choose (Malone, 1981; Rotter, 1954; Weiner, 1979 ). The second objective of this study was to validate whether or not these structured computer simulations hold intrinsically motivating characteristics for children. Measures of continuing motivation, such as choosing to return to an instructional task in a free-choice situation, have been used successfully to estimate the construct of intrinsic motivation (eg. Kinzie & Sullivan, 1989). Continuing motivation can be defined as an individual's willingness to return to an activity once external pressure to do so has ceased (Maehr, 1976).

There were two purposes to this study: 1) to investigate the effects of computer animated presentations on intentional and incidental learning; 2) to investigate the locus of motivation to participate in computer-based practice activities. It is hypothesized that students in lessons containing animated presentations will significantly outperform other students on measures of incidental learning. It is also hypothesized that students will choose to return to practice activities involving interactive dynamics more often than other computer practice activities or even other high-interest, non-lesson activities, such as paper puzzles.

## METHODS

### Subjects

The subjects consisted of 70 fourth grade students from an urban public elementary school. Participation was voluntary with selection based on parent consent.

### CBI Lesson Content

The CBI lesson, first developed for previous studies (Rieber, in press-a, in press-b; Rieber & Hannafin, 1988) but modified for this study, described and explained Newton's laws of motion. The lesson was divided into two parts. Part one introduced students to Isaac Newton and his first law of motion. Part two provided applications of Newton's first law and an initial application of Newton's second law where mass is held constant and forces vary. All information was presented at an introductory level in the context of one-dimensional motion.

### Lesson Versions

Two levels of Visual Presentation (Static Graphic, Animated Graphic) were crossed with two levels of Practice Order (Questions/Simulation, Simulation/Questions).

Visual Presentation. In each Visual Presentation condition the lesson narrative was supplemented with either static or animated graphics. In the Static Graphics condition, forces were represented by a foot giving an object a kick, such as a ball or a concrete block. Motion and trajectory attributes were represented by arrows and path lines. The Animated Graphics condition also used the ball, block and foot symbols, however the object was then animated to show the motion and trajectory resulting from the force applied to it. Both types of visuals elaborated the textual information. However, another application of Newton's second law was incidentally demonstrated in the Animated Graphics condition. This law predicts that when two objects of different masses are both acted on by the same size force, the acceleration experienced by the object with larger mass is less. The computer animated a large solid box moving very slowly across the computer screen after being kicked with the same size force which had just been applied to a small animated ball. No attempt was made to teach or explain why the box moved more slowly than the ball.

Practice Order. Each level of Practice Order consisted of giving all students two types of practice activities, but in different order. The first practice activity consisted of multiple-choice questions. The questions covered the relevant material in the respective lesson part. Feedback was provided to the students in the form of knowledge of correct results. The second practice activity involved the student in a structured simulation. Students were given increasing levels of control over a simulated, free-floating object called a "starship" in the lesson. This structured simulation, an application of the dynaturtle microworld developed by diSessa (1982) and White (1984), had been shown to positively affect lesson performance in prior research with children of this age (Rieber, in press-b). Students participated in the practice activities in the respective order (Questions/Simulation or Simulation/Questions) after each of the two lesson parts. It was important that all students have equal opportunities to experience both forms of practice so that interpretation of the free-choice data would be valid. However, it was anticipated that one activity might orient students to the second activity, thus resulting in different success patterns for each activity. This could affect the motivating appeal for each activity. Therefore, Practice Order was added to the experimental design to prevent this from confounding the study. It was not the intention of this experiment to study the performance effects of each practice activity, as this has been adequately demonstrated elsewhere (e.g. Rieber, in press-b).

### Dependent Measures

Posttest. The 24-item posttest measured two types of rule learning: intentional and incidental. Intentional learning is defined as learning those objectives which were directly taught in the lesson through the combination of verbal (text) and visual means. Incidental learning is defined as learning those objectives which were not directly taught, but only implied through contextual cues provided in several of the animated visual displays. The posttest was administered twice: first, in two parts immediately upon completion of the relevant lesson parts, and then again approximately two days later in whole as a measure of learning decay/durability. The use of visuals in the testing was also controlled. Half of the intentional and incidental questions were presented in an all-verbal form and half contained accompanying visuals. Two questions were added to the final administration of the posttest which tested a simple application of Newton's Law of Gravitation. This objective was not taught in any form during the lesson. However, it was anticipated that the animated visuals might promote the misconception that two objects of different masses would fall at different speeds when dropped to the earth. These two questions provided a preliminary measurement of whether such a misconception was actually formed.

KR-20 reliability of all 50 questions was .93. Respective reliability coefficients and number of questions for each of the subscales were as follows: .87, 24 (Immediate); .87, 24 (Delayed); .91, 28 (Intentional); .95, 20 (Incidental); .91, 26 (Verbal); .85, 22 (Visual); .64, 2 (Law of Gravitation).

Response Latency. The time required by students to process each of the posttest questions was collected. Processing time is measured as the time (in seconds) taken by students to press the appropriate key once prompted to do so. This variable provides an important indirect measure of the organization strength of initial encoding as evidenced by retrieval time.

Continuing Motivation. Immediately after completing the second administration of the posttest on the fourth day, students were given three choices: 1) answer more practice questions just for fun; 2) spend more time in the structured simulation; or 3) complete a word find puzzle on another topic. Students were told that they could switch between activities if they wished to do so. Continuing motivation of the practice activities was measured by first choice frequencies of these two options as compared to the first choice frequency of the puzzle activity.

### Procedures

All instruction and testing was administered by computer over the span of four, 30 minute computer sessions. The first session acted as a general orientation which familiarized the students to the people and materials of the project. The second session presented lesson part one, followed by practice and then 12 posttest questions relevant to that part. The third session presented lesson part two, followed by practice and then 12 posttest questions relevant to part two. The fourth session involved a re-administration of the original 24 posttest questions and 2 additional questions which measured Newton's law of gravitation. As already indicated, these two questions were added as a preliminary measure of whether the animated graphics promoted misconceptions. After the posttest, students were given the choice to work on either of the two computer-based practice activities (questions or simulation) or an irrelevant, though highly motivating activity consisting of a word find puzzle. Each session lasted approximately 30 minutes amounting to about 120 minutes of learner time over the course of about 10 days. Students were randomly assigned to one of the treatment groups as they arrived at the computer lab for the first session. Once instructed to begin at the start of each session, students completed the lesson individually under controlled conditions.

### Design

In this study a 2 X 2 X (2 X 2 X 2) factorial design was used. Two between-subjects factors levels (Visual Presentation, Practice Order) were crossed with three within-subjects factors (Learning Intent, Visual Testing Format, Test Time). The between-subjects factors consisted of two levels of Visual Presentation (Static Graphic, Animated Graphic) and two levels of Practice Order (Questions/Simulation, Simulation/ Questions). The within-subjects factors consisted of two levels of Learning Intent (Intentional, Incidental), two levels of Visual Testing Format (All Verbal, Verbal/Visual), and two levels of Test Time (Immediate, Delayed). A mixed factor analysis of variance (ANOVA) was used to analyze the quantitative data. The within-subjects factors also served as dependent measures. A Chi Square analysis was used to test students' first choice preferences of each post-lesson activity as a measure of continuing motivation of the practice questions and the simulation.

In addition, separate analyses were conducted on the questions measuring misconceptions of Newton's law of gravitation and the response latency data from the posttest.

## RESULTS AND DISCUSSION

### Posttest

Percent means and standard deviations of student posttest scores are contained in Table 1. A significant main effect was found for Visual Presentation, $F(1,66)=60.17$, $p=.001$, $MS_e=2649.37$. However, interpretation of this effect must be qualified because of its interaction with Learning Intent, $F(1,66)=18.73$, $p=.0001$, $MS_e=2249.61$. Figure 1 illustrates the nature of this interaction. Students in the Animated Graphics group performed similarly on both intentional (mean=74.2%) and incidental questions (mean=67.5%), whereas students in the Static Graphics group performed significantly better on intentional learning questions (mean=57.4%) than incidental questions (mean=16.3%). As expected, these latter students performed at about the guessing level on incidental questions. This result supports the first hypothesis of this study that students receiving animated demonstrations of incidental information would attend, understand, and retrieve this information when tested although no formal attempt was made to teach or explain the principle. The superiority of the Animated Graphics group over the Static Graphics group on intentional learning is consistent with previous research (Rieber, in press-b).

Among the within-subjects factors, significant main effects were found for Learning Intent, $F(1,66)=31.28$, $p=.0001$, $MS_e=2249.61$, and Visual Testing Format, $F(1,66)=5.39$, $p=.02$. Not surprisingly, students scored higher on questions measuring Intentional Learning (mean=65.6%) than questions measuring Incidental Learning (mean=41.1%). Students scored higher on questions containing either a static or animated visual (mean=60.1%) than questions containing no visual (mean=51.4%). However, a significant interaction was found between these two factors, $F(1,66)=5.62$, $p=.02$, $MS_e=357.52$. Students tended to answer Incidental Learning questions which contained visuals more accurately than questions which contained no visuals. Student scores on questions measuring Intentional Learning did not vary significantly depending on the use of visuals in the questions. In this study, the use of visuals in the test construction did not measure differentiated amounts of intentional rule learning. However, test questions which included visuals did vary in their measurement of incidental rule learning.

Insert Table 1 About Here

Insert Figure 1 About Here

### Response Latency

A main effect was found for Test Time, $F(1,66)=46.13$, $p=.0001$, $MS_e=35.99$. Students took significantly less time to answer the posttest questions during the second administration of the posttest. Retrieval time would be expected to decrease during retesting, especially when the second administration occurred within 48 hours, as was the case in this study. However, an ordinal interaction was found between Test Time and Visual Presentation, $F(1,66)=5.48$, $p=.02$, $MS_e=35.99$. Students in the Statics Graphics group varied less in response time from the first and second administration of the posttest than students in the Animated Graphics group. This interaction is probably an artifact of the rate of guessing on incidental questions by the Static Graphics group.

A main effect was found for Learning Intent, $F(1,66)=80.89$, $p=.0001$, $MS_e=30.80$. Students took significantly less time to answer questions measuring Intentional Learning than questions measuring Incidental Learning. However, an ordinal interaction was also detected between Learning Intent and Visual Presentation, $F(1,66)=8.77$, $p=.004$, $MS_e=30.80$. Students in the Animated Graphics group took significantly longer to answer questions measuring Incidental Learning than students in the Static Graphics group. This was expected. Students in both Visual Presentation groups were required to overtly process incidental information for the first time during the posttest. Since students in the Static Graphics group had to revert to either guessing or personal experience, their latency rates for these questions would be expected to be lower than for students in the Animated Graphics group. These latter students were asked to answer questions pertaining to information which was only incidentally represented in the animated visuals. If students encoded the incidental information significant time would be necessary to retrieve this information and formulate a rule which could be used to answer the question. There was no difference in response time between Animated Graphics and Static Graphics groups for Intentional Learning.

A main effect was found for Visual Testing Format, $F(1,66)=126.97$, $p=.0001$, $MS_e=31.15$. Overall, students took much less time to respond to questions which contained either static or animated visuals than questions which contained no visual supplements. This too was expected. All of the information and testing was highly visual in nature. Questions which did not provide external visuals would require students to form their own internal or external (eg. doodles on paper) images in order to solve the problems. When visuals were provided with the questions, students could by-pass this time-consuming cognitive step, assuming that the visual was congruent with each student's mental schema. It is insightful to compare the latency and performance results for this factor. Even though the addition of external visuals to questions which measured intentional learning did not contribute to performance differences, the decrease in latency suggests that these visuals nonetheless aided the cognitive processing necessary for accurate responses.

### Continuing Motivation

Respective first choice frequencies for each of the three post-lesson activities were as follows (the first number indicates the raw frequency and the second number indicates percentage of total first choices): Questions, 3, 4.3%; Simulation, 42, 60.0%; Puzzle, 25, 35.7%. For the purposes of the Chi Square analysis, answering more practice questions acted as a non-choice and was removed from the analysis. Overall, students first chose to participate in the structured simulation more often than either the puzzle activity or the practice questions, $X^2=3.88$, $p<.05$, $df=1$. This result supports the second hypothesis of the study which contended that the practice provided by the structured "starship" practice held intrinsically motivating appeal for the students. It is contended that this appeal would lead students to choose to stay on task longer in meaningful ways. This result further clarifies performance effects of this practice activity as reported by Rieber (in press-b).

### Student Conceptions of Gravitation

A significant main effect was found for Visual Presentation, $F(1,66)=18.24$, $p=.0001$. Students in the Animated Graphics group (mean=5.9%) performed significantly worse on the two questions measuring a simple application of Newton's law of gravitation than students in the Static Graphics group. This suggests that students in the Animated Graphics group were more prone than other students to the misconception that Newton's second law predicts the free fall characteristics of objects of different masses on earth. This result provides an important counterbalance to the apparent ability of students to attend to animated visuals which incidentally demonstrates a scientific principle. While students may be appropriately attending to the details, they may be drawing a whole series of conclusions — some of which are appropriate, and some of which are not. This phenomena is consistent with previous research on other misconceptions in science where people formulate conceptions of physical phenomena based on daily observable events (see Eylon & Linn, 1988, for a review). Without direct guidance, such as that provided by instruction, students may formulate innumerous and potentially erroneous "theories" about the physical world.

## GENERAL DISCUSSION

There were two purposes to this study. First, the ability of students to first attend to incidental information contained in an animated visual, and then extract and induce science principles was investigated. The Animated Graphics group was given demonstrations of an extension of Newton's second law where the masses of two objects varied, but the forces acting on them remained constant. However, the fact that these demonstrations represented a distinct extension of this principle was never brought to their attention. In fact, the demonstrations were presented in the context of explaining other lesson content. It is believed that attention to intentional learning alone placed significant cognitive loads on students. Yet, they were able to gain understanding of the incidental information, without apparently sacrificing any intentional learning. The results reported here demonstrate the rather startling ability of fourth grade students to attend, formulate, and apply even a sophisticated science principle introduced in an incidental fashion.

However, this result is tempered by the alarming number of students who continued to apply this incidental information to other, inappropriate contexts. Students in the Animated Graphics condition were much more likely to hold misconceptions about the effects of gravity on objects of different masses. This is not really surprising. The animated demonstrations of Newton's second law occurred in a simulated gravity-free/frictionless environment. The concept and effect of gravity was purposely removed from the discussion. Without additional guidance, it is logical and intuitive to apply Newton's second law to contexts where objects of different masses are freely falling on earth (such an intuitive assumption led Galileo to demonstrate otherwise at the leaning Tower of Pisa).

The second purpose of this study was to estimate the construct of intrinsic motivation as it related to several practice activities shown effective in CBI in previous research — questioning strategies and structured simulations. Understanding whether certain activities have intrinsic motivating appeal is important when designing CBI. If activities contain such appeal for students, they will be more likely to maintain interest and stay on-task for longer periods of time. This is because the focus of the reinforcement is internal — that is, students motivate themselves. This is contrast to traditional CBI, largely based on behavioral designs, where learning is believed to be the result of constant and appropriate external reinforcement. It can be argued that internal reinforcers account for most informal daily learning such as that experienced through hobbies and sports. Designers of CBI practice activities have many strategies from which to choose. It is argued here that while several activities may promote similar performance levels, activities which are intrinsically motivating carry other significant advantages such as personal satisfaction, challenge, and relevance and promotion of a positive perspective on lifelong learning (cf. Keller & Suzuki, 1988). Previous research has used student free choice patterns as a measure of continuing motivation (Kinzie & Sullivan, 1989). In this study, students overwhelmingly chose to return to the "starship" practice more often than questioning activities or even traditionally "fun" activities such as word find puzzles to support the contention that the structured simulation carries intrinsically motivating appeal for students of this age. It is further contended that the activities, and not the computer, possesses these characteristics based on the fact that of the other two choices, the paper and pencil activity was overwhelmingly chosen over the remaining computer activity (questions).

This study has provided preliminary findings concerning the role of visuals in computer-based testing. Testing learning outcomes which are highly visual in nature poses problems for researchers. A visual in a test question may actually act as an unintentional learning aid which could confound results. However, the validity of testing visual learning outcomes with solely verbal means can easily be questioned. This study hoped to gain insight into this dilemma by controlling for visuals in the testing. In this study, the validity of questions measuring intentional learning was not related to the presence of visuals. Questions which did not contain visuals appeared to state the problem in terms which enabled students to form their own appropriate internal images. This was not true when measuring incidental learning. Students apparently had difficulty forming internal images on their own which could solve the problem. More work is needed to understand the role of visuals in testing (other examples include Hale, Oakey, Shaw, & Burns, 1985; and Taylor, Canelos, Belland, Mayton, & Dwyer, 1989).

Also, students in this study did not experience significant learning decay over two day test-retest interval. Previous studies have indicated that picture effects are durable over long periods of time (Anglin, 1986; Peng & Levin, 1979). The results reported here support this contention.

In conclusion, this study has shown one example of the powerful ability of students to learn in incidental ways. Designers of CBI need to harness this ability by promoting it whenever possible while trying to avoid inappropriate student elaborations. One application of this research to the development of CBI may be to use incidental information as an orienting activity for subsequent intentional instruction. More research is needed to understand how to best incorporate incidental learning benefits into the design of CBI. Additionally, this study has provided strong evidence to suggest that certain computer practice activities contain intrinsically motivating appeal for elementary school students. Future research should be directed at replicating these results in other contexts and content areas.

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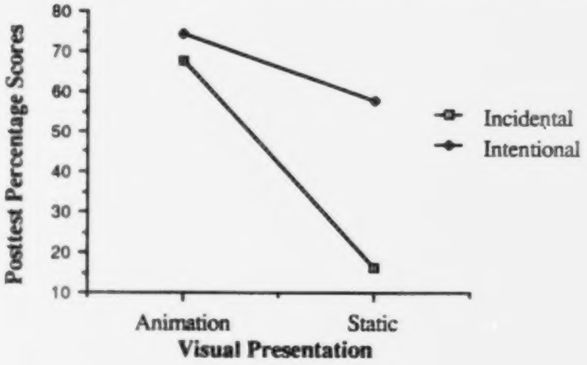
Table 1. Mean Percent Scores and Standard Deviations for the Posttest

| | | | Immediate Posttest | | | |
|---|---|---|---|---|---|---|
| | | | Intentional | | Incidental | |
| Visual Presentation | Practice Order | | Verbal | Verbal/Visual | Verbal | Verbal/Visual |
| Animated Graphic | Questions/ Simulation | Mean | 73.5 | 69.9 | 66.4 | 76.5 |
| | | SD | (30.7) | (27.3) | (29.4) | (28.3) |
| | | n | 17 | 17 | 17 | 17 |
| | Simulation/ Questions | Mean | 75.5 | 69.1 | 59.7 | 76.5 |
| | | SD | (24.4) | (26.2) | (32.0) | (36.8) |
| | | n | 17 | 17 | 17 | 17 |
| Static Graphic | Questions/ Simulation | Mean | 61.8 | 53.7 | 15.1 | 29.4 |
| | | SD | (21.9) | (27.2) | (13.8) | (28.6) |
| | | n | 17 | 17 | 17 | 17 |
| | Simulation/ Questions | Mean | 66.7 | 52.6 | 15.0 | 22.8 |
| | | SD | (35.1) | (31.6) | (25.0) | (31.5) |
| | | n | 19 | 19 | 19 | 19 |

| | | | Delayed Posttest | | | |
|---|---|---|---|---|---|---|
| | | | Intentional | | Incidental | |
| Visual Presentation | Practice Order | | Verbal | Verbal/Visual | Verbal | Verbal/Visual |
| Animated Graphic | Questions/ Simulation | Mean | 74.5 | 81.6 | 69.7 | 70.6 |
| | | SD | (28.3) | (18.8) | (27.6) | (37.0) |
| | | n | 17 | 17 | 17 | 17 |
| | Simulation/ Questions | Mean | 68.6 | 79.4 | 65.5 | 66.7 |
| | | SD | (25.6) | (18.2) | (27.7) | (37.3) |
| | | n | 17 | 17 | 17 | 17 |
| Static Graphic | Questions/ Simulation | Mean | 52.9 | 59.6 | 16.0 | 17.6 |
| | | SD | (21.4) | (28.5) | (23.6) | (33.6) |
| | | n | 17 | 17 | 17 | 17 |
| | Simulation/ Questions | Mean | 54.4 | 59.2 | 10.5 | 15.8 |
| | | SD | (37.6) | (32.8) | (24.2) | (28.0) |
| | | n | 19 | 19 | 19 | 19 |

Notes: SD-standard deviation; n-number of subjects

Figure 1. Interaction Between Visual Presentation and Learning Intent



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# COMPUTER-BASED INSTRUCTION AND ITS NON-COMPUTERIZED ENVIRONMENT

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## ABSTRACT

Learning improved when instruction in introductory logic shifted from a traditional large lecture/drill session model to a large lecture supplemented by main-frame, computerized feedback and discussion in homogeneous groups formed as a result of a computer inputs. Test scores declined only slightly when instruction shifted again to large lecture covering 17% more material and PC-based feedback and individualized help instead of group discussion. Test scores then improved quite significantly when the large lecture sessions were replaced by video presentations, workbooks and graduate assistant-led discussions. Hypotheses about television learning, teaching in general and teaching introductory logic predict the success of such a multi-faceted learning environment.

Our instruction of Introduction to Logic has been Computer-Assisted since Fall, 1976. Until Fall, 1988, we employed either mainframe- or PC-based computer instruction along with lecture-based class presentation of materials. In Fall, 1988, while retaining PC-based computer instruction, we switched to a video-based class presentation of materials.

Through all those years, computer-based instruction has conduced to student learning, and we summarize those data below. But, in accordance with the focus of this conference on broader issues, the purposes of this paper are two. For the most part, we report the considerable success of the present video/discussion-based presentation of materials in conjunction with PC-based computer instruction. We also raise questions and make observations about how to blend computer-based instruction in the light of the goals and content of instruction.

From Fall, 1976, through Spring, 1987, we oversaw and periodically taught Introduction to Logic to 400 students per semester. Twice per week students assembled for lectures. During the second of those meetings the students took short, not-for-grade quizzes. Through the Teacher Information Processing System, their IBM answer sheets were read and individualized, hardcopy messages were printed out for them. One of those messages assigned them to the homogeneous discussion group in which they met for the third period of the week, to discuss their problems as reflected on the quiz.

This method of instruction compared favorably with its predecessors in which students received no systematic feedback prior to examinations for grade. Even though the students' workload was increased when the system was initiated, student scores improved significantly on material required under the older and newer format. Over the lifetime of TIPS, with many instructors in the course, student test scores reflected a 4% improvement over pre-1976 test scores.

This method of instruction, however, had significant shortcomings. (1) It depended heavily on the quality of lectures the students heard, and the temporary faculty often assigned to teach the course could not match the test averages of the two senior professors who most regularly taught the course. (2) It provided students scant opportunity to obtain feedback during lecture periods. And (3) students who missed lecture for any reason had to rely on notes taken by other students. Moreover, (4) it did not give students ongoing and immediate opportunities to receive feedback on their progress.

The failure of the main-frame based computerized instruction to provide ongoing and immediate feedback to students was sufficient reason, in our eyes, to abandon the TIPS as soon as strong courseware became available for PCs. Accordingly, in Fall, 1987, we adopted The LogicWorks, a menu-driven software program distributed by the Philosophy Documentation Center with built-in, clear and simple instructions which allow students to perform all the typical classifications and evaluations required of introductory logic students.

It would be satisfying to report that the immediate and ongoing feedback opportunities provided by The LogicWorks resulted in higher student test scores, but they did not. In truth, test scores declined an average of almost two percent per student in both semesters of 1987-88.

This result was not, however, discouraging, inasmuch as students in 1987-88 were required to spend two and a half weeks of a fifteen week semester on materials not required of students prior to Fall, 1987 (studying immediate inference, refutation by logical analogy, inductive arguments and quantification symbolization). We knew that, with the introduction of The LogicWorks, students had tested significantly higher at Stetson College (where Rob Brady, the program author, teaches). And we were sufficiently convinced that students would learn more using The LogicWorks than they had using TIPS that we increased the student workload without ever testing whether students would actually test higher if course content remained stable while the method of computerized instruction changed. The only data we collected related to the shift showed that students expressed a more positive mean preference for LogicWorks than they had for TIPS.

The major reason we did not take a year to test the effectiveness of The LogicWorks with our students was that we were still concerned about the other perceived shortcomings of our course. No matter who taught the course, the large lecture format discouraged interaction between professor and students during class time. And in Spring, 1987, the quality of instruction provided by a temporary faculty member assigned to the course led the department to ask the two senior professors most familiar with the course to take over all instructional duties for the duration of the semester.

For those reasons, we decided that, by Fall, 1987, when we instituted The LogicWorks, we would also use course lectures redesigned for eventual conversion to a videotape format. Thus foregoing a clear test of the effectiveness of LogicWorks over TIPS, we decided that within the new video-based/PC-based format, we could cover 17% more material in the course.

During 1987-88, employing The LogicWorks for the first time, we were reassured of its value by student reactions to it. Replacing the discussion groups used with TIPS, we put 40 students (most of them without computer experience) infront of PCs with two graduate assistants assigned to teach them how to use The LogicWorks and to assist them with understanding the course material, particularly as reflected on The LogicWorks. The undergraduate students reported these sessions (consisting of group discussion of exercises in their text and individualized help with computer-posed problems) more helpful than the predecessor discussion sessions.

Meanwhile, the senior professor began to devise the materials they hoped would address the remaining major problems in the course. In Fall, 1986, one lecture was videotaped before a live student audience. By Spring, 1987, the edited version of that presentation, complete with graphics and script on screen, was presented to students. Those students were immediately thereafter surveyed for their reactions to the videotape. The students found the presentation clear and they agreed that it fully covered the topic. The edited videotape, however, took only thirty minutes, not the fifty minutes the lecture would have taken, and the students perceived the quickened pace. They felt rushed and unable to take appropriate notes.

With this mixed feedback, we began devising twenty-six video presentations. Now the literature on television learning has said for three decades that television learning is no better than as effective as non-media formats. We, nevertheless, began our work optimistically in the light of three sets of hypotheses, hypotheses about how to overcome the problems of television learning, hypotheses about effective teaching, and hypotheses about how to handle the special problems of teaching logic.

Hypotheses about video learning. (VL1) Because televised instruction moves too quickly, a workbook outlining the major points of each presentation and containing the definitions and examples could avoid time-consuming writing and enhance learning. (VL2) Because different students have different learning styles, video learning will be more effective as it is able to present the same material in a standard variety of ways. (VL3) Because most logic students learn at least in part by doing, video presentations will be strengthened if supplemented by computer exercises to which students get regular, immediate and constructive feedback.

*Action on video learning hypotheses*. (VL1) Don Scherer and one of his graduate assistants, Chris Sayre, created a workbook, *The Logical Thoughts*, which provides students a complete outline of each lecture except that it leaves several crucial blanks students must fill in with key words and phrases. (VL2) The style of Professor Stuart's television presentation is very linear, carefully sequenced with abstract statements regularly followed by clear examples. When several comments form a sequence, they are repeatedly connected to the same illustration. All the definitions appear on screen against a blue background which repeats the word Definition, while Professor Stuart speaks voice-over. When the content is not a definition, but a caution, an assumption or basic information, different backgrounds for text-on-screen are used. When contrasts are made, yellow highlighting is used to mark the distinguishing terms which appear at the same spot on the screen. When extended contrasts are made, a hot and cool color are systematically employed to mark the contrast. When video skits are used as illustrations, script is used on screen during reprises of the skits, in standard locations, to focus the students' attention on the application of the abstract point. All these conventionalized procedures, unavailable in traditional lectures, are employed to help students with different learning styles to grasp the material. (VL3) One simply should not expect students to learn skills without practice. Video learning can be expected to do no more than to prepare students for successful practice on their skills. The course operates on the hypothesis that video presentations and a good computer program will reinforce each other in introductory logic. Our experience from 1976-88 had convinced us that student learning improves with regular, computerized feedback.

*Hypotheses about effective teaching*. (ET1) Because students might become excessively passive during a video presentation, opportunities for discussion (in groups of 36) immediately following presentations averaging 25 minutes will make students more active, and hence better, learners, and (ET2) also because students might become excessively passive during a video presentation, providing partially taken notes to students will stimulate them to be alert regarding how to complete their notes. (ET3) Because video presentations can be replayed, students will schedule replays when they miss class and when they need review. (ET4) Because students will leave class with an outlined set of notes, completed in class, they will use them successfully as a study guide.

*Actions on effective teaching hypotheses.* (ET1) Television learning is not significantly more passive than lecture hall learning. But the presumption that active learning is better led Professor Stuart in devising a lesson plan for each session for the graduate teaching assistants. On the basis of clear ideas about typical student problems with each session, Stuart devised questions, hints and cautions for assisting the graduate students in engaging the undergraduates in each lesson. (ET2) In particular, discussion typically begins by ensuring that each student *understands* how each blank in the notes is to be filled in. (ET3) During the first semester of using the videotapes, the students ordered 159 replays of tapes (6.12 plays per tape), 60% of them in the last seventy-two hours prior to examinations. (ET4) On student evaluation forms compiled at the end of the first semester of the use of *Logical Thoughts*, students agreed (3.49; 4 = strongly agree, 3 = agree) that *Logical Thoughts* helped them to learn the material.

*Hypotheses about teaching logic*. (TL1) Because students find such concepts as the validity of an argument sufficiently abstract to impair comprehension, the use of audio and audio-visual skits will provide students with clear, experiential referents for difficult logical concepts. (TL2) Because students regularly understand complex logical transformations in their professor's office which they do not clearly see on a chalkboard or overhead at the front of a lecture hall, script on the television screen moving through carefully sequenced transformations, using color and flashing for emphasis, will improve students' understanding of sequenced transformations. (TL3) Because a student's understanding of logic requires grasping how several pairs of concepts turn on small but crucial distinctions, the student notes should include blanks which make the student write in the contrasting terms in the second definition and the script on screen should use parallel constructions and visual presentations to emphasize the similarities and differences between the contrasting items.

Action on teaching logic hypotheses. (TL1) The video presentations also contain 19 video skits and eight audio skits designed to make important points about basic logic concepts. The video skits were written by Karen Gygli, a doctoral student in Theatre. Without previous background in logic, she read the text and wrote a series of 45-150 second scripts from one hundred word descriptions of what each skit should illustrate. To improve their verisimilitude, she took as the subject matter of her skits what the College Student Personnel literature defines as the developmental concerns of typical college students. These scripts where then revised by us and videotaped as performed primarily by students of the BGSU Theatre Department under Ms. Gygli's direction. The 20-50 second audio scripts serve the same ends but employ more stereotyped human situations. Written by Professor Scherer, they are inserted into the videotapes with script on screen. (TL2) Appropriate sequences of screens were produced for voice-over inclusion in the video presentations. As many as 150 screens are included in the most involved presentations, allowing for much greater precise reference than can be achieved in lecture halls. (TL3) As noted above, Logical Thoughts was created including crucial blanks.

The completed products were used for the first time this fall (1988). At that time the course was evaluated both in terms of student response to the course and in terms of student learning. Students thought well of the elements of the course related to its video/computer representation. Recording 4 for Strongly Agree, 3 for Agree, 2 for Disagree and 1 for Strongly Disagree, the following means were attained:

2.94 The logic video presentations were helpful in my learning the material.
2.88 My graduate teaching assistant helped me to understand the video presentation.
2.48 I liked the logic video presentation.
2.94 The logic computer program helped me to learn the material.
3.01 My graduate teaching assistant helped me work with the computer program.
2.69 I liked the computer program.
3.55 Logical Thoughts helped me follow the video presentations.
3.49 Logical Thoughts helped me to learn the material.
2.29 The logic textbook helped me understand the material.
2.01 I liked the logic textbook.

These results show that, although we were using the best known, most popular textbook in the country, students liked it less and found it less helpful to their learning than the video, computer and workbook elements in the course. The results are encouraging in that they consistently show that students, separating their judgments of learning from their likes, found all the new materials more helpful for learning than likable. Finally, the results indicate that the videos and the computer program are materials graduate assistants can use effectively with undergraduates.

In terms of student learning, data have been collected from all four exams given in the course. The average scores attained by students on these exams have been compared with student averages from similar exams given last year when the two senior professor taught the large lecture format. (The material covered in the course under the two formats is virtually identical.) The results are presented in Table 1.

Table 1

| | 87-88 | Fall 88 | Spring 89 |
|---|---|---|---|
| Students | 600 | 250 | 300 |
| Exam 1 | 70.58 | 72.70 | 71.87 |
| Exam 2 | 72.61 | 73.54 | 75.36 |
| Exam 3 | 70.66 | 80.27 | 81.83 |
| Exam 4 | 66.11 | 77.91 | 78.63 |

(All scores are percentages.)

In summary, then, grades went up 6 1/3% or about two-thirds of a letter grade. The size of the groups and repetition of the Fall, 88 results in Spring, 89 strongly suggest that more than a Hawthorne effect is involved. If these results hold up for the exams given in Fall, 1989, they will strongly indicate that the goal of ensuring quality instruction for the logic class has been achieved.

Many people familiar with computer-assisted instruction have asked us whether we see the course elements we now use as half way toward a video disk or other technology that would allow our visual and computer elements in the course to become interactive. For several reasons, we do not foresee that development. (1) Logical Thoughts has proved very successful, but it would no longer be convenient for students to take notes while watching a video if they were continually reaching computer interaction points. If a hardcopy record of new understandings helps students review for tests, we hesitate to remove the heuristic of that devise. (2) Many of our previous students projected that students using the videos would find them impersonal. In many video courses lecturer figures are perceived as impersonal. But in this course, few students have mentioned this as a problem. Our belief is that the presence of the graduate teaching assistant in the classroom and the reassurance of human help undermines that impression. In Spring, 1989, the instructor of record replaced a weekly office hour with a review session in a lecture hall, reinforcing the impression of available human help. Students who attended these voluntary sessions reported themselves appreciative and the help beneficial. (3) Students do not uniformly find the video presentations helpful. Some find discussion with the graduate assistant or reading the text or reviewing Logical Thoughts more crucial to their learning. The students' present ability, then, to manipulate the sequence of involvements with the computer doubtless helps some of them learn better from the computer program.

Learning has significantly improved in 1988-89. While former improvements have occurred when computerized instruction was the new element of instruction, the recent improvement tends to confirm the hypothesis that the strengths of video instruction, packaged notes, immediate discussion and personal interactions can enhance the quality of learning even in such a skills-based, abstract subject matter as introductory logic.

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# MULTI-DISCIPLINARY INTELLIGENT COMPUTER ASSISTED LEARNING

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## ABSTRACT

First year students in undergraduate programs typically experience difficulty in relating basic theoretical concepts with practical applications. In an attempt to minimise this discrepancy, Computer-Assisted Learning (CAL) applications were developed to provide Information Science and Occupational Therapy undergraduates with a learning resource designed to assist in developing links between theory and practice links. To support current CAL technology, the applications was implemented using fundamentals of Intelligent CAL (ICAL) working with the concept of a knowledge base and a student delivery or inference process. While the knowledgebase changed, the student delivery routines remained constant. Development was based on traditional tools to assess their viability for intelligent systems. Attitudinal surveys of students who undertook the lessons suggested that such applications can help reduce the theory-practice discrepancy and that the ICAL was perceived as a desirable component of both curricula. Instructional implications and options for further research are considered.

## INTRODUCTION

The wealth of research into the application and benefits of Computer-Assisted Learning (CAL) is well documented. More recent research on student-centred CAL (Farrow & Sims, 1987) has highlighted the importance of students being able to apply their own knowledge to a situation and, through feedback, comparing their understanding to that of an expert. This approach has provided a framework for modifying the traditional instructor-centred CAL application. As research into CAL has determined it to be an effective learning resource and well received by students, it has traditionally been employed as an adjunct to classroom teaching. However, CAL also has the facility to address higher-order cognitive and affective skills through the introduction of Intelligent Tutoring Systems (Kearsley, 1987). The benefits of Intelligent CAL (ICAL) may be seen in the individualising of instruction through student control of the learning material.

Over the years, many authoring languages and systems have been released to both the educational and business sectors (Sims, 1985). However, these tools have typically promoted the instructor-centred tutorial approach for courseware development and delivery. With advances in Artificial Intelligence (AI), the potential arose to more accurately simulate teacher-student dialogs through the provision of a knowledge-base accessed through a rule-based inference module (Black, 1986; Kearsley, 1987).

However, many educators motivated to implement AI-based courseware have been restricted due to a lack of computer-science or programming skills. Nevertheless, certain authoring systems provide comprehensive programming and logic structures, and it is the contention of the authors that courseware may be generated which provides students with an intelligent and useful learning medium, provided that intelligence is based on an interpretation of a student's individual response to particular situations.

To assess the potential of authoring tools for ICAL, a multi-disciplinary research project was established, focusing on two vocational programs: Information Science and Occupational Therapy. The background and suitablity of these two disciplines is based on the strong links between disciplinary theory and work practices.

Like many other disciplines, Information and Library Science are being influenced by the introduction of computer technology. In recent years, the discipline has also recognised the potential of computers as a teaching device. Early research (Stark, Horn & Slavens, 1972) demonstrated the viability of CAL in the teaching of library reference skills. More recently, CAL was considered as an assistant to on-line searching and information retrieval (Large & Guy, 1982). As technology developed, the potential of expert systems has also influenced the Information Science discipline, to the extent that knowledge bases are perceived as an important avenue for problem solving (Yaghmai & Maxin, 1984). However, the role of expert systems has been as an adjunct to Information Science activities rather than a teaching tool (Borko, 1985). From another perspective, CAI is perceived as a viable, but untried, resource for media centres (Main, 1987). Overall, CAL has received minimal attention in the Information Science discipline.

At Kuring-gai College of Advanced Education (KCAE), first year students in the Bachelor of Applied Science (Information) program undertake an intensive unit (The Information Environment) in the first two weeks of their undergraduate studies. The intent of this unit is to generate an overview of the theories underlying the program through discussion and analysis of information related issues. From verbal feedback and assignment content, it was evident that many students encountered difficulty in achieving the objectives of the introductory unit.

More specifically, students commented that the unit generated "information overload" and did not adequately consolidate the basic concepts, to the extent that theoretical issues and practicalities of Information Science were not sufficiently connected. This situation indicated a discrepancy between current and desired performance, prompting an evaluation of alternative instructional techniques to aid in the development and increase student understanding of the content.

From this evaluation, a research project was initiated to asses the effectiveness of Computer-Assisted Learning (CAL). CAL was chosen for three reasons. First, recent political pressure in Australia has required tertiary institutions to provide more flexible teaching programs; CAL provides this through individual, self-paced programs available on demand. Second, the priorities of the School of Library and Information Studies currently emphasise the need for additional instructional resources; CAL is recognised as a valid instructional medium, though receiving minimal attention at KCAE. Third, the availability of CAL would increase student contact with technology, an essential element of the course.

To ensure the courseware conformed to state-of-the-art technologies, a learner-centred format was adopted, including an intelligent interface. This interface was designed to provide students with the maximum opportunity to explore theory-practice links. While this approach simplifies various complexities of Artificial Intelligence, it was designed to determine its potential use for teachers without computer-science skills, enabling access to authoring tools and courseware with which the student may interact intelligently. If the student is able to receive feedback which, as far as they are concerned, has been analysed and represents an expert's opinion, then it may be considered an intelligent system (Stern, 1987; Sims, 1989).

The research project therefore set out to evaluate the potential of developing a CAL application based on the principles of AI, using traditional authoring tools, which would provide students with a medium in which they could explore the relationships between Information Science theory and practice. The project would examine the potential of readily available authoring systems to develop a "shell" which would provide a multi-disciplinary system for courseware development and delivery. By developing ICAL learning materials to integrate with the teaching of the introductory unit, it was hypothesised that students would have a more thorough understanding of the theory/practice relationship in Information Science. The initial phase of the study involved development of an application for the Information Science discipline, followed by an extension to multi-disciplinary considerations. The research project focused on three areas:

a) the viability of authoring tools to develop ICAL applications

b) the usefulness of courseware in linking theory and practice

c) the use of CAL in an institution with little background in the use of technology as a teaching aid.

To assess the potential for courseware to address multi-disciplinary content, the second phase of the research involved the development of an alternate knowledgebase (in Occupational Therapy) to be delivered by the same student and tutorial modules used for the Information Science lesson. This progression is illustrated in Figures 1(a) and 1(b) below:

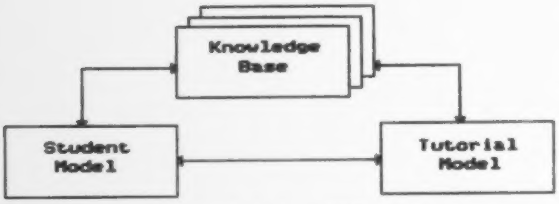


Figure 1(a): Initial ICAL Structure

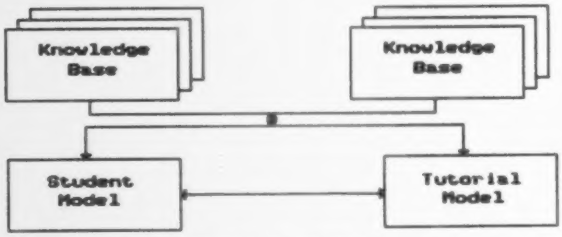


Figure 1(b): Multi-Disciplinary Structure

The content for the Occupational Therapy knowledgebase was extracted from client records and the theoretical frames of reference described by Hopkins & Smith (1986).

## METHODOLOGY

### Authoring Tools and Courseware Development

Of the many authoring languages and systems available, a number were evaluated in terms of two criteria: (a) able to be used by teachers across disciplines and (b) able to build a knowledgebase accessible by inference from student responses. After careful consideration, the authoring system chosen was PCD3 (Control Data Corporation), as it satisfied both criteria as well as providing comparatively advanced authoring and programming capabilities.

The development of the coursware was based on standard Instructional Systems Design methodologies (for example, Briggs, 1977; O'Neil, 1979; Romiszowski, 1986). While such methodologies require considerable effort, the paucity of good courseware and the quality of resources developed using such principles justified the approach (Sims, 1988a). The design took into account the need to maximise the efficiency of the learner-computer interface by minimising the requirements for computer literacy to access and operate the courseware. These included concise instructions for the activity and clear instructional displays, permitting maximum control of the learning cycle (Sims, 1988b).

The structure of the courseware itself was based on ICAL foundations, with students having access to a knowledge base in order to explore the relationships between both Information Science and Occupational Therapy theory and practice. For the research project, the basic presentation strategy is illustrated in Figure 2, in which students are presented with a practical scenario to which they had to respond. Depending on the analysis of the student's response to that scenario, the student is informed of the theory or concept which they applied to that scenario.

For this project, the parsing of student responses was restricted to terms relevant to the disciplinary theories, due to restraints in development time rather than the authoring tool employed. The overall structure, as shown in Figure 1(a), includes a knowledge base of content, a tutorial model to deliver the appropriate content and a student model to analyse individual learning levels and provide data for the tutorial functions. The content was developed based on subject-matter expertise from School teaching staff and pilot-tested for performance accuracy.

### Attitudinal Survey

A short attitudinal survey was developed to gather data from the subjects. The survey was primarily designed to provide an indication as to whether subjects demonstrated a positive attitude to (a) the use of courseware to develop theoretical-practical links and (b) the use of courseware in their whole program. In addition, some demographic data was collected to analyse the characteristics of students entering the course.

### Subjects: Information Science

The subjects were 91 full-time and part-time first year students enrolled in their first year of the Bachelor of Applied Science (Information) in the

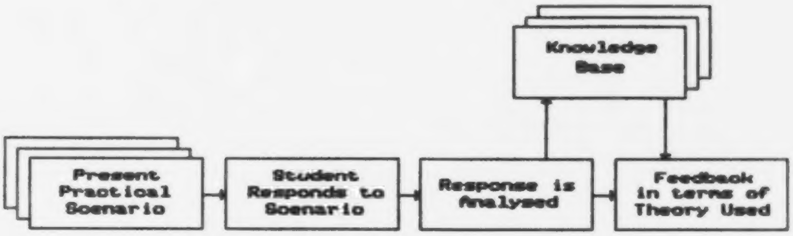

Knowledge Base
Present Practical Scenario
Student Responds to Scenario
Response is Analysed
Feedback in terms of Theory Used

Figure 2: Basic Presentation Strategy

School of Library and Information Studies, Kuring-gai CAE. Students were required to take the CAL as part of their tutorial work.

Procedure: Information Science

The courseware was installed on the college IBM-PC network and each tutorial group undertook the lesson during their scheduled class time and were provided with a short introduction as to the reason for the study. Subjects were permitted as long as required to complete the tutorial. After finishing the lesson, students were asked to complete the attitudinal survey on their work.

Subjects: Occupational Therapy

The subjects were 42 full-time undergraduate students in the first semester of their first year in the Occupational Therapy (OT) program. All students had received several lectures in theoretical frames of reference of OT and their relevance to OT practice in the unit "History and Practice of Occupational Therapy".

Procedure: Occupational Therapy

The ICAL lesson was installed on IBM-PC compatibles in two separate locations. The first a small private tutorial room available to students between 9am and 5pm on weekdays. Access was limited due to the heavy academic program (25 contact hours per week). The second an open computer room with access 7am to 11pm weekdays and 9am to 9pm weekends; in this instance, the lesson was installed on the network file server.

Students were advised that they could elect to work on the lesson either individually or in small groups, and were advised that a group should not consist of more than three students. Subjects were requested to complete an evaluation after finishing the lesson.

Three weeks after the lesson was studied, students completed a test which formed part of their assessment for the unit. A tear of questionnaire asked students to rate the perceived value of lectures and tutorials and ICAL in assisting them understand the link between OT theoretical frames of reference and their application to the practice of OT.

## RESULTS

Courseware Development

The authoring tool selected was able to produce a prototype which allowed the students to receive intelligent feedback to their responses. While the prototype did not include a facility to explain the feedback, the PCD3 system appeared to have this potential.

Information Science

Tables 1 and 2 document the demographic data for the subjects. The feature of the population is the large percentage of female (60/91) and mature age students (63/91). Of the 91 subjects, 69 had used computers previously.

| | Mature | School | TOTAL |
|---|---|---|---|
| Male | 22 | 9 | 31 |
| Female | 41 | 19 | 60 |
| TOTAL | 63 | 28 | 91 |

Table 1: Entry Level by Sex

| Computer Use | Mature | School | TOTAL |
|---|---|---|---|
| Used | 54 | 15 | 69 |
| Not Used | 9 | 13 | 22 |
| TOTAL | 63 | 28 | 91 |

Table 2: Entry Level by Computer Use

The first attitudinal question asked students to indicate whether the lectures had provided a clear link between theory and practice in terms of the Information Provision model. Table 3 illustrates those subjects who disagreed with Question 1 (the theory presented in lectures was difficult to interpret) and yet agreed with Questions 2-5 (on the benefits and use of CAL applications in the program). Of the subjects who disagreed with Question 1 (19/91) there was a tendency to perceive CAL as a viable alternative. This table supports the contention that students will benefit from using an alternative medium to explore theory and practice.

| Respondent | n | Percentage | | | |
|---|---|---|---|---|---|
| | | Q2 | Q3 | Q4 | Q5 |
| Disagree Q1<br>Agree Q2-Q5 | 19 | 73 | 80 | 69 | 97 |

Table 3: Disagree Q1: Agree Q2-5

Alternately, Table 4 depicts the percentage of subjects who agreed with Question 1 but disagreed with questions 2-5. Very few of those who felt the lectures were a suitable medium disagreed with the use of CAL as an alternative.

| Respondent | n | Percentage | | | |
|---|---|---|---|---|---|
| | | Q2 | Q3 | Q4 | Q5 |
| Agree Q1<br>Disagree Q2-Q5 | 72 | 10 | 4 | 5 | 4 |

Table 4: Agree Q1: Disagree Q2-5

Finally, Table 5 compares the results for each of the CAL attitudinal questions, which clearly indicates an overall demand for CAL as a teaching tool.

| Response | Q1 | Q2 | Q3 | Q4 | Q5 |
|---|---|---|---|---|---|
| Agree | 79 | 83 | 85 | 87 | 89 |
| Disagree | 21 | 12 | 13 | 8 | 5 |
| No Opinion | 0 | 5 | 2 | 5 | 6 |

Table 5: Percentage Responses Q1-5

### Occupational Therapy

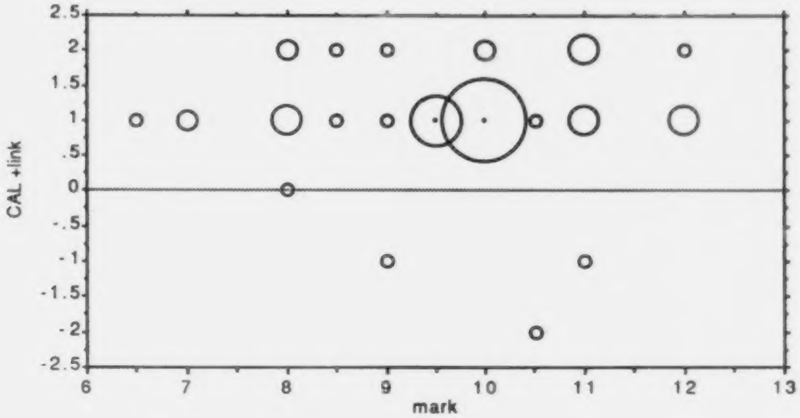
The results from the Occupational Therapy phase of the project compared favourably with the Information Science findings, providing further support for the use of advanced CAL applications in undergraduate teaching. Further analysis of responses to the attitudinal survey however, revealed several interesting trends, as documented in Table 6.

| Variables | Correlation |
|---|---|
| Q1 v Q2 | 0.255 |
| Q2 v Q3 | 0.636 |
| Q1 v Q3 | 0.065 |
| Q1 v Q4 | 0.198 |

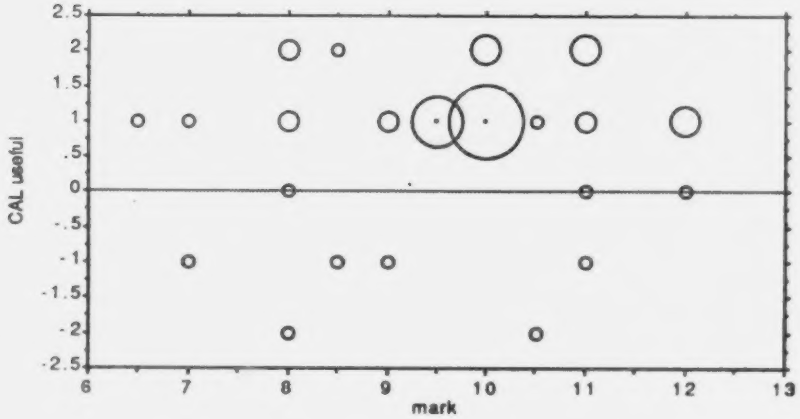
Table 6: Correlation Analysis

Comparing Question 1 (that the lectures provided a clear theory-practice link) with Question 2 (that the CAL provided a link to clinical applications of OT approaches) revealed a correlation of 0.255, suggesting a tendency towards a preference for one or other of the resources used (lecture or CAL). This result also supports the Information Science findings shown in Tables 3 and 4.

Conversely, those who ranked the CAL as effective in linking theory and practice also ranked CAL as a useful instructional medium (correlation 0.636). This finding tends to support the belief that CAL (and in this case ICAL) can be used to effectively assist students



Graph 1: Test Mark vs Theory Practice Links



Graph 2: Test Mark vs Usefulness of CAL

develop a theoretical foundation to their practical studies, when those students value the CAL medium. Alternately, those who viewed the lectures as valuable were less likely to see CAL as a useful medium (correlation 0.065).

However, there was also minimal relationship (correlation 0.198) between linking theory and practice through lectures and understanding the clinical relevance of the various OT approaches (Question 4). Overall, the findings from the attitudinal survey not only support those from the Information Science study, but also suggest that the ICAL approach adopted in these studies can assist students develop further understanding in the links between theory and practice.

A second part of the OT study compared post-test results with those from the attitudinal survey; it should be noted that all students undertook both lectures, tutorials and CAL on the content. As illustrated in Graph 1, there was a tendency for those who agreed that CAL helped in linking theory and practice to score highly on the test. Similarly, Graph 2 reflects a preference for CAL by those who performed well on the test.

## DISCUSSION

### Courseware Development

As far as could be ascertained from this study, the PCD3 authoring system (and presumable others) have the potential to develop complex courseware which will provide the student with intelligent, interactive learning resources. However, it is apparent that to develop such courseware, the author will have to resort to traditional programming techniques such as IF...THEN...ELSE structures and control through system and author-defined variables. One of the main aspects of the PCD3 system which enabled the development of this courseware was its unlimited flexibility in response processing and feedback control.

However, the main conclusion which can be drawn is that while available authoring tools can produce intelligent CAL resources, courseware development such as this remains the domain of personnel skilled both in programming techniques and instructional design. This supports earlier observations (Sims, 1985) which questioned the promotional claims of selected authoring products in terms of their ease-of-use and productivity. Overall, this phase of the project has confirmed the potential of authoring systems to produce individualised, intelligent courseware. However, it is suggested that its success will depend on the ability of the instructional designer and author to use all of the authoring tool's facilities.

## Information Science

With respect to the demographic data, it is evident that the population was skewed towards mature aged female students (Table 1). While this may not be representative of the tertiary education system, it is typical of recent student intakes into the B.App.Sci.(Information) program. However, while most of the subjects had previous computer experience (Table 2), one interesting feature to emerge was that some 50% of high-school entrants had not used computers before. This is especially surprising given the emphasis by State Education Departments on developing computer literacy skills. Overall, the population characteristics were consistent with previous intakes into the program.

The most important aspect of the results is depicted in Table 3, which shows the percentage results for those students who disagreed with Question 1 yet agreed with Questions 2-5. The graph indicates a highly positive attitude towards both the lesson (Question 2) as well as CAL in general (Questions 3-5), supporting the contention of the research that students can enhance the theory-practice links through a CAL medium. Verification of this trend will involve refinement of the courseware and more extensive response analysis.

In comparison, the results shown in Table 4 illustrate (as percentages) those students who found the formal lectures useful, but did not agree to the potential of CAL as a learning medium. This finding supports the theories of individual differences in learning, whereby students prefer particular media for instruction and emphasises the need for a variety of instructional resources in the educational environment. In terms of CAL, this supports the need for instructional developers to look at alternative techniques for courseware structure to allow for individual differences, without developing parallel courses based in different presentation styles. As instructional development is an iterative process, any limitations in courseware can be reduced through regular enhancements.

With reference to the results depicted in Table 5, it is apparent that a very high proportion of students expressed a positive attitude towards the use of CAL and its ability to provide an environment in which practical scenarios of Information Transfer theory could be presented and discussed.

## Occupational Therapy

The courseware developed for the Occupational Therapy component of the study benefited from the initial module and used a more graphic representation for the knowledgebase. However, the student delivery and judging remained identical, although content from the knowledgebase was used for the judging routines.

Results from the attitudinal survey compare to those from the Information Science component and provide substantive support for the use of CAL/ICAL as adjunct learning resources. Perhaps most important is the potential for CAL to address the theory-practice links as well as providing students with an alternative medium to explore program content. These findings will also support those educators who wish to provide students with the widest range of instructional resources possible.

## Conclusions

These findings are significant in that there is evidence to suggest that CAL applications may be used to enhance student awareness through developing associations between classroom theory and vocational practicalities. In supporting earlier studies (Farrow & Sims, 1987), the trends revealed encourage further research into the use of ICAL to enhance those theory-practice links.

There is also the potential for teaching institutions to consider investigating higher levels of CAL through incorporating the basic elements of ICAL and allowing students to explore the knowledgebase rather than using the computer as a surrogate teacher. By moving towards a learner-centered approach and providing exploratory learning environments, CAL has the potential to increase students perception and understanding of the importance of theory in their chosen vocation.

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# The Effect of Learning Objectives on Comprehension Monitoring During Computer-Based Instruction

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## ABSTRACT

In this study, the effects of learning objectives on the ability to estimate understanding of lesson content were studied. During a lesson on ionospheric theory, subjects were provided orienting objectives and/or review objectives. Overall results indicated that students provided with review objectives without orienting objectives and those receiving both orienting and review objectives obtained significant relationships between their estimation and their end-of-lesson test score. Though variability occurred during the lesson, review objectives were found to improve the accuracy of estimation more than the other treatments.

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Researchers stress the importance of instruction that can adapt to individual learner differences (see for example Messick, 1984; Di Vesta, 1975; Glaser, 1977; Cronbach & Snow, 1977). Various methods of lesson control have been implemented to customize treatments to learners (Steinberg, 1977; Tennyson, Tennyson, & Rothen 1980). Lesson control can be conceptualized as being on a continuum ranging from designer control to learner control. In designer control, lesson sequence decisions are imposed externally; in learner control, they are made by the learner. Learner control is often viewed as a preferred method to tailor individually relevant approaches to instruction (Merrill, 1975). Yet to date, unaided learner control has not proven consistently effective (Tennyson, 1980; Ross & Rakow, 1981). Steinberg (1977) reports that students "were simply not good judges of their achievement levels" (p.86).

Comprehension monitoring refers to the students ability to assess their knowledge of the learning task. Research in comprehension monitoring (August, Flavell & Clift, 1984; Markman, 1977) indicates that students often do not correctly monitor their comprehension.

Garhart and Hannafin (1986) suggested that methods which clarify the criteria for monitoring, such as the use of learning objectives, may improve the comprehension monitoring of students. Learning objectives are statements of intended lesson outcome (Melton, 1978; Hamilton, 1985). As such, they specify the criteria for successful completion of a lesson and indirectly provide a concrete referent for estimating learning. Objectives typically are presented either before lesson segments (focus attention on forthcoming, relevant content), or after the lesson (providing a rehearsal strategy). The focusing properties of learning objectives should strengthen the learners task knowledge and objectify completion criteria, consequently enhancing estimation of understanding.

The rationale for this study is that specific task information in the form of objectives can enhance the comprehension monitoring ability of learners. The position of task information, either before or after the lesson presentation may influence the learner's comprehension monitoring differently. In this study, the effects of objectives presented either prior to, or upon completion of, lesson segments on the accuracy of comprehension monitoring was investigated.

## METHODS

### SUBJECTS

The subjects for this study consisted of 42 undergraduate students enrolled in an introductory course in educational psychology at The Pennsylvania State University. The subjects volunteered for the study and were awarded extra credit points for participation.

### MATERIALS

The lesson content for this study consisted of elementary facts and concepts on the ionosphere. The subjects selected for this study possessed the prerequisite knowledge for this lesson but were assumed to be unfamiliar with the specific lesson content.

The lesson was divided into three sections. Section one consisted of nine text and graphic frames which provided introductory information on the ionosphere such as, origin, location, and composition. Section two, which consisted of 11 text and graphic screens, presented the characteristics of the ionosphere's layers: name, location, and relative density. Factors that cause changes in the size, location, and density of the ionosphere were presented in sections three which consisted of 14 text and graphic frames.

For this study, four lesson versions were created: Orienting Objectives and Review Objectives, Orienting Objectives and No Review Objectives, No Orienting Objectives and Review Objectives, and No Orienting Objectives and No Review Objectives.

### Orienting Objectives and Review Objectives

The first frame in each lesson section presented the section's learning objectives. Following the objectives, the lesson material was presented. Next, the students estimated their understanding with learning objectives. The last phase of each section was a section test.

### Orienting Objectives and No Review Objectives

This version was the same as version one except that no objectives were included with the estimation of understanding exercise.

### No Orienting Objectives and Review Objectives

This version was the same as version one except that the initial objectives were omitted.

### No Orienting Objectives and No Review Objectives

This version was the same as version one except that the initial objectives and the objectives with the estimation exercise were omitted.

All lesson versions consisted of an introduction followed by three discrete lesson sections. Each section contained an orienting phase, the lesson, and an estimation of understanding phase. The final phase in each section was a test covering lesson materials presented only during that section.

During the orienting phase, lesson objectives were presented. The implementation method consisted of short statements of forthcoming lesson material. Objectives were congruent with section content and the posttest.

The estimation task required that the student rate his/her understanding on a numerical scale. For section one, this scale ranged from zero to seven. The range of the numerical scale equated to the number of questions that would be asked during the subsequent exam.

The estimation phase was followed by a section test. Each section test consisted of multiple choice test items that were congruent with the stated lesson objectives. Each item contained five response alternatives. Feedback for each item was given based on the correctness of the student response. The following feedback was used uniformly for all test items: Correct answer, "Correct, let's continue"; incorrect response: "The correct answer is (A-E dependent on each item), let's continue."

## PROCEDURES

Students were randomly assigned to one of the four treatment groups upon arrival to class. Participants were provided with a basic explanation of the requirements of the study and a statement of the purpose of the study.

Since the materials were setup in advance, the student's physical activities consisted only of keyboard entries. All lesson data (run time and test question responses) were recorded to a data disk, while all lesson activities were conducted using the computer.

The study was conducted during eight sessions over a four day period. Students signed up for a one hour block of time and were randomly assigned to a treatment group upon arrival to the class.

## RESULTS AND DISCUSSION

The Pearson Product Moment correlations between estimations of learning and actual test scores were computed by section and overall test. The correlations are contained in Table 1. Using overall test scores, the strongest main-effect relationship was found for the review objectives group ($r=.69$, $p<.01$). Significant correlations were also found for orienting objectives ($r=.50$, $p<.05$) as well as no orienting objectives ($r=.49$, $p<.05$).

TABLE 1. CORRELATIONS BETWEEN POSTTEST SCORES AND ESTIMATION RATINGS

| | Review Objectives | No Review Objectives | Totals |
|---|---|---|---|
| Orienting Objectives | .61<br>($p<.05$) | .40<br>(NS) | .50<br>($p<.05$) |
| No Orienting Objectives | .84<br>($p<.01$) | .48<br>(NS) | .49<br>($p<.05$) |
| Totals | .69<br>($p<.01$) | .36<br>(NS) | |

The strongest orienting x review treatment relationship was found for review objectives without orienting objectives ($r=.84$, $p<.01$) followed by orienting objectives with review objectives ($r=.61$, $p<.05$). The no review treatment combinations consistently yielded the lowest overall correlations as well as the lowest main-effect ($r=.36$, NS).

## GENERAL DISCUSSION

The results of this study suggest that providing learning objectives will enhance comprehension monitoring ability. Objectives in general seem to provide the cues necessary to strengthen the comprehension monitoring process.

The position of objectives seems to have a profound effect on estimation accuracy. Review objectives since they were presented with the estimation exercise, might have been judged to be immediately relevant and therefore used as the criteria for estimating understanding.

Orienting objectives did not have the same effect on estimation accuracy as review objectives. Since the position of presentation for orienting objectives was removed from the estimation exercise, students may have judged them to be of minimal value. Consequently, less attention might have been given to orienting objectives than review objectives. This phenomena might be accounted for by Melton's (1978) findings that students who do not know how to use objectives or have not found them effective in the past, may not attend to them.

As a method of imparting completion criteria, objectives seem to provide a basis for estimation. The overall requirement for this type of assistance may indicate that learners do not attend to lesson learning outcomes in sufficient detail to make effective learning and consequently learner control decisions.

This study has raised several questions concerning how students monitor their comprehension of lesson materials during computer-based instruction. Based on this study, we can tentatively conclude that students require some sort of aid in establishing the criteria for lesson completion. Other methods of specifying completion criteria may also be effective in improving comprehension estimates. These include adjunct questions, orienting strategies, feedback on processing time, etc. Further research should clarify the uses for objectives and other methods of specifying completion criteria.

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# Transfer of Computer-Related Skills Between Different Computing Environments

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*Abstract*

The rapid evolution of computer hardware and software has meant that users must frequently transfer computer-related skills to new computing interfaces or environments. Are some computing environments superior for fostering transfer? This paper describes an experiment to examine the transfer of novices' word processing skills between a Macintosh-type environment and a program using a traditional command-line interface.

*Introduction*:

The acquisition of computer-related skills has become crucial for success in school, the workplace and society at large (National Commission on Excellence in Education, 1983). However, unlike subjects such as mathematics and English composition, in which the basic skill requirements tend to remain stable from year to year, the skills required to use computers have tended to change as frequently as the technology changes. It is especially important, then, to understand not only how students can best acquire computer-related skills, but also how previously-learned knowledge and skills relating to computers may aid or hinder the learning of new knowledge and skills -- an effect called transfer of learning.

Although transfer has been one of the most heavily studied areas in educational psychology (Royer, 1979; Underwood, 1983; Cormier & Hagman, 1987), the vast majority of research has concentrated on very specific or "near" transfer effects in behaviorally-oriented verbal learning experiments. Within the past few years, cognitive psychologists have developed theories that describe transfer in terms of internal cognitive structures and that attempt to explain general or "far" transfer effects (Singley & Anderson, 1985; Cormier & Hagman, 1987). Similarly, Anderson (1982) has described a three-stage theory of cognitive skill acquisition that explains how the nature of skill learning changes with practice.

Based on these theories of skill acquisition and transfer, it was hypothesized that, for novice computer users, certain computing environments—that is, the human-computer interfaces—are more likely than others to foster transfer of computer-related skills. Specifically, certain aspects of the Apple Macintosh environment, by utilizing "intuitive" interface devices such as pictorial icons in a familiar "desktop" environment, and mouse-controlled selection of commands from a menu, were hypothesized to foster transfer of basic editing skills to a different type of computing environment. In this case, the second environment was a more traditional computing environment that required recall and entry (by keystrokes) of abbreviated language-oriented commands, such as those required by MS-DOS-based programs.

Two fundamental premises guided this study: (a) Subjects who learn their initial word processing skills on the Macintosh will acquire a superior mental model — or schema — for word processing, because of the transparent simplicity of the Macintosh environment and its use of concrete icons as symbols for abstract concepts and operations; and (b) the possession of this schema will aid these students, by transfer of learning, in acquiring similar skills on a second, more difficult or "opaque" word processor.

The usefulness of these and other aspects of the Macintosh environment for the acquisition and transfer of a functional schema for computer interaction and word processing (which would then augment specific skill acquisition) is supported by research in such areas as visual imagery (Alesandrini, 1985; Kaufmann & Helstrup, 1985) and learning by analogy (Gick & Holyoak, 1983).

### *Subjects and Methods*

Eighty-one undergraduate students with minimal computer knowledge and no word processing experience were assigned to one of two experiments, and within each experiment to a treatment group or a control group with 17 to 21 subjects per group. In the first part of the first session, all subjects viewed a videotape that instructed them in basic computing and word processing concepts. In addition, subjects' problem-solving abilities, attitude toward learning about computers, typing abilities and demographic data were assessed for use as possible moderator variables.

In Experiment 1, the treatment group spent 2 hours learning four basic editing skills in MacWrite, a word processor designed for the Macintosh. The editing skills were: (a) insert and (b) delete single characters, (c) delete and (d) move blocks of text. The learning sessions were conducted on the computer and consisted of a series of 3 drill-and-practice exercises and tests for each of the editing skills. The control group performed a neutral task on the Macintosh for a comparable amount of time.

In the second session 48 hours later, both groups learned editing skills on Wordstar (on the IBM PC/AT), which requires users to recall keystroke combinations to input commands. A similar series of drill-and-practice exercises and tests were used for this learning phase. In the final part of the second session, both groups used Wordstar to perform a 12-minute novel editing test that was designed to simulate a "real world" editing task. This test consisted of 10 prose paragraphs with editorial corrections marked on a paper copy; subjects made the designated editing changes on their computer using their newly-learned skills. This final editing test was considered to be a far transfer task, and the results were used as the primary dependent measure.

In Experiment 2, the sequence of word processors was reversed; the treatment group learned Wordstar editing skills first, while the control group performed an unrelated task on the same IBM/PC's In the second session, both groups learned MacWrite and performed the novel editing task on MacWrite.

### *Results*

In both experiments, some mixed transfer effects were observed for the individual editing skills tests in the learning sessions. Positive effects tended to favor the experimental groups, with the strongest effects occurring with learning of the simpler skills.

In Experiment 1, however, an analysis of variance demonstrated that the treatment group performed significantly better than the control group on the novel editing test (F (1,39) = 4.6, $p < .05$). In Experiment 2, the analysis of variance showed no significant difference between the treatment and the control group for the novel editing test (F (1,39) = .29). An analysis of covariance (using problem-solving ability and typing ability scores as covariates) produced similar results. These results confirmed predictions made in the research hypothesis.

In addition, an examination of significant ($p < .05$) correlations between the final edit test scores and various premeasures showed that for control subjects, only typing ability was indicative of successful performance; on the other hand, problem-solving ability was important for the success of experimental subjects in Experiment 1. The latter results tend to corroborate aspects of Anderson's (1982) theory of cognitive skill acquisition.

### *Discussion*

The problem of the present study was to identify a "hands-on" learning and practice experience with one word processor that would foster transfer to a different word processor. An analysis of this problem reveals that it is not merely the specific software program or the type of hardware that is responsible for the clarity of our mental model of a computing system. Users interact with the working combination of hardware and software—the human-computer interface or environment—and it is through the interface that the user must work and learn.

Until recently, few computing interfaces were designed for ease of use or with the user's intuitive understanding in mind. Most computing systems have traditionally been designed to improve the power and efficiency of the computing system itself, with the assumption that the user will adapt to the system, rather than the other way around. The Macintosh computer is an exception in this regard, and it was selected as the type of computing system that could best serve as a learning tool for conveying generic computing concepts. Its interface was designed to be understood intuitively, through pull-down menus and manipulable icons that are analogous to common office functions. Wordstar (version 3.x), on the IBM PC, was chosen as a contrast because its interface is generally acknowledged to be difficult to understand and use. Its on-screen presentation and command syntax has changed little from its earliest version, which had its roots in mainframe text editors.

Nevertheless, the basic functions performed by the two word processors are identical; that is, they are analogous devices. As analogues, each might be expected to foster transfer of skills to the other, when compared to students who learn skills on only one device (Gick & Holyoak, 1983). However, transfer occurred from MacWrite to Wordstar, but not in the opposite direction. This result provides evidence that some feature or features of MacWrite and/or the Macintosh are responsible for fostering transfer.

The *type* of transfer—far or near—is also important for the practical instructional implications of the study. In many fields, from mathematics to English composition, students may perform competently in classroom exercises, yet fail in situations where they must apply their skills; that is, in far transfer situations. Likewise, recent trends in cognitive psychology stress that the context of the dependent measure is crucial for the ecological validity of the study (Brewer & Nakamura, 1984). Therefore, the emphasis of this study was on the results of the final edit test, because performance on this test is similar to the type of task that students and writers must perform in a practical editing situation.

The comparison of the scores on the drill-and-practice tests between the control and treatment groups showed mixed results, and it is doubtful that much near transfer occurred between the specific skills of the two word processors, because of their dissimilarity. Near transfer is more likely to occur when there is close similarity between the specifics of the learning task and the transfer task (Royer, 1979; Underwood, 1983). However, far transfer did appear to occur for the group that worked with MacWrite first, as evidenced by the results of the novel editing task. The format of this test was unfamiliar to all subjects, and required not only correct execution of an editing skill, but also selection and application of the appropriate skill for a task. Selection and application requires an *understanding* of a skill, which is a type of knowledge that goes beyond simple rote learning (White & Mayer, 1980).

### *Summary and Conclusion*

Simply put, the conclusion is that MacWrite on the Macintosh is a better learning tool for fostering transfer of generic word processing skills than is Wordstar on the IBM. The skills that were learned with MacWrite/Macintosh were generic in the sense that they transferred successfully to the new learning situation and could be mapped onto new (yet analogous) skills, as they were presented. Subjects' familiarity with these generic skills evidently gave them a competitive edge over other (control) subjects who did not have those skills, when all subjects attempted a practical, applied editing task—a task that required them to extend the performance of their new, rote-learned skills into new and untried areas.

On the other hand, editing skills learned on Wordstar apparently did not transfer to MacWrite, presumably because they were too specialized to contribute to the construction of a comprehensive schema for word processing editing skills. It is further presumed that the lack of this schema was responsible for subjects' failure to experience positive transfer on the far transfer task.

The assumption behind most educational and training curricula is that prior learning will usually be remembered to some extent and that it will have a positive effect on related material that is learned later. A conclusion to be drawn from this study is that this assumption is not always warranted; evidently, some computing environments support transfer of skills, while others do not. In terms of applications to practice, the results indicate that care must be taken in choosing or planning the initial computing environment for computer novices. A long-range goal of this and related studies is to influence the specification of a curriculum of computer-related skills, one that takes into consideration the inevitable need for transfer of skills to new—and as yet undeveloped—computing environments.

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# Metaphor and Instruction

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## Abstract

Metaphors are everyday occurrences, and numerous writers have commented on their educational implications. This paper reviews relevant literature on metaphor, both theoretical and empirical. It relates theories of metaphor and theories of comprehension and scientific discovery. Additionally it considers the literature on learning and metaphor. Finally it concludes with recommendation for using metaphors in instructional situations.

## Introduction

Metaphor is all around us. We operate computer systems that have *ports* that connect us to *networks*. On *screen* we see *windows* with *menus*, *folders*, *buttons*, or *desktops*. We *scroll* through *pages*, and then we *cut* and *paste* with various *tools*. Since Lakoff and Johnson's (1980) book, *Metaphors We Live By*, the idea that our everyday language is permeated with metaphor is a commonplace. In recent years, a wide variety of writers (Benzon and Hays, 1987; Bump, 1985; Fetterman, 1988; Florin, 1988; Heitland, 1981; Herron, 1982; Hewson and Hamlin, 1985; Klein, 1987; Kloss, 1987; Marshall, 1988; Moore, 1987; Munby, 1986; Regan, 1984) have commented on the general implications of metaphor for learning and instruction. Nowadays, the idea that metaphor has instructional implications is not unusual.

The study of metaphor dates to at least Aristotle's *Poetics*, and the number of theories that have been proposed makes simple summary impossible. In recent times, two scholars defined the outlines of metaphor research: I. A. Richards and Max Black. Richards (1936) established the terminology for discussion of metaphor. Richards suggested that a metaphor consisted of three parts: the tenor (now called the topic), the vehicle, and the ground. Modern usage varies slightly from Richards' meanings but today most scholars would classify a metaphor such as "Man is a wolf" as containing a topic (Man), a vehicle (wolf) and a ground (an unstated relationship which maps the qualities of wolves onto Man).

Black (1962) proposed the categorization of metaphor theories into two classes: the interaction and substitution views of metaphor. In introducing the substitution-interaction distinction, Black was among the first since Richards to write analytically about metaphor. Black held that the substitutionist view of metaphor is only a shorthand for a literal comparison. From this point of view, metaphor is a rhetorical device, a way of making a statement of similarity more pleasing or compelling. Metaphor, according to this perspective, is equivalent to a simile or analogy. The only differences are that, in the case of a simile, the adverb "like" or "as" is present; in the case of an analogy, the full four terms (A:B::X:Y) are present.

This implies that if one says that "The heart is a pump" that is equivalent to saying that hearts resemble pumps in various salient ways. One salient feature of pumps is that they move a liquid more or less continuously. By this reading, the meaning of the metaphor can be defined entirely by a set of underlying similarities between pumps and hearts.

Accordingly, metaphor has no special importance; it is just a substitute for a literal comparison and a literal account would serve just as well.

Many psychologists (Malgady & Johnson, 1976, 1979, 1980; G. Miller, 1979; Ortony, 1975, 1979; Osgood, 1980; Sternberg & Tourangeau, 1982) have adhered to the substitutionist view. It follows that if metaphors are just rhetorical substitutes they have few implications for instruction. Educators have implicitly adopted this view, which can be traced back to Locke (1706/1961), and have generally ignored metaphor as an instructional strategy or been hostile to it (Green, 1979).

The interactionist view of metaphor has mainly been advanced by philosophers (Black, 1962, 1978, 1979; Hausman, 1975; Haynes, 1975; MacCormac, 1985; Richards 1936; Wheelwright, 1962). The essence of the interactionist position is that a metaphor cannot be reduced to a set of literal propositions without some significant loss of semantic content. This is because metaphors create similarities which did not exist before the metaphor was uttered. If I say "Chevrolet is the heartbeat of America" the automobile is not merely classified as being like a heartbeat. The metaphor restructures our thinking about both Chevrolets and heartbeats. This "radical creativity thesis" (Black, 1979) is controversial, but if true, would clearly have educational implications. It would mean that metaphors can convey content that cannot be communicated in any literal way and can create links between disparate semantic domains.

## Metaphor and Comprehension

Much current research on metaphor in instruction stems from Ortony's (1975) proposal in which he advocated the educational benefits of metaphor. He cited three reasons why metaphors are helpful in education: they are vivid, they express the inexpressible, and they are informationally compact. The vividness hypothesis holds that metaphor presents information in a particularly concrete manner, thereby aiding retention. The inexpressibility hypothesis holds that some ideas which cannot be expressed literally can be expressed metaphorically. The compactness hypothesis holds that metaphors "chunk" information, increasing communicational efficiency. An additional aspect of Ortony's thesis is that metaphor allows a transfer of meaning from something well-known to something less well-known. If we say that electricity "flows" we are saying that electricity can be thought of in terms of water, a more familiar domain. Gentner and Gentner (1983) investigated this metaphor and found differential cognitive effects as compared to a "teeming crowds" metaphor.

Haynes (1975) and Johnson (1980) have interaction-theoretic positions on the relation between metaphor and comprehension. Haynes argues that metaphoric comprehension involves "... imaginative inference which is rule-breaking, non-rational, irreducible, gestalt, the emergent whole that is the discovery.... Metaphor...is the point at which concepts are modified" (p.277). Johnson holds that "... metaphors generate novel structurings of our experience in ways not fully anticipated by our available systems of concepts.... By causing a reorganization of our conceptual frameworks they institute new meanings" (p.65).

Ortony's position contrasts with the above in that new knowledge is presumed to be related to the old by assimilating it to an existing cognitive structure. Restructuring does not take place. Haynes and Johnson, however, assert that metaphors cause a reorganization of knowledge to express new relationships.

This contradiction may be resolved by Petrie's (1979) account of metaphor. Petrie explains metaphor in Piagetian terms, asserting that the substitutionist position accounts for assimilation but cannot explain accommodation. Petrie proposed a model of how metaphor may modify cognitive structures. Essentially, cognitive structures are modified by changing search constraints as a result of empirical observations and metaphorical insights.

## Metaphor and Scientific Discovery

Numerous writers have commented on the frequent use of metaphors, imagery, and analog models in the process of scientific discovery (see, for example, Hanson, 1958; Hesse, 1966; Kuhn, 1979; Leatherdale, 1974; A. Miller, 1984; Paivio, 1979; Turbayne, 1962). Kekulé's snake, Maxwell's lines of force, and Bohr's solar system model of the atom are all well known examples of metaphorical models which led to scientific advances. Hoffman (1980) discussed the many roles of metaphors in science and concluded that they are probably "...inevitable and necessary to science..." (p. 407).

In science, it is usually held that there are two two stages of activity: Discovery and confirmation (Bechtel, 1988). It is only during the discovery stage that metaphors are likely to be helpful. Green (1971, 1979) argued that metaphors are not necessary but that they are useful heuristics in the context of formulation of knowledge. Green (1971) asserted that metaphors serve a function in the early invention of knowledge but that they cannot be used to demonstrate the truth of a proposition. Since metaphors are a form of imagery, Kaufmann's (1985) reference to the historic belief that imagery is important in the invention stages of thinking suggests a reason for the usefulness of metaphor in discovery. Gordon (1961) also emphasized that visual imagery is important in the discovery stage of learning, whereas verbal symbols are important in the confirmation stage. Pearson, Raphael, TePaske, and Hyser (1981) found a familiarity-by-metaphoricity interaction which supports the idea that metaphoric imagery is useful primarily when dealing with unfamiliar material. The evidence from scientific discovery suggests that if metaphors are a mediating device then they should be most useful in the early stages of understanding.

## Metaphor and Learning

Although there may be positive effects of metaphors on learning there may also be negative effects. Because metaphors appear to be anomalous some writers have speculated that metaphors require additional processing beyond that required by literal language (e.g., Searle, 1969). Ortony, Schallert, Antos, and Reynolds (1978) tested a three-stage model based on Searle that hypothesized that metaphor comprehension involved (1) literal interpretation of the metaphor, (2) verification of this interpretation in terms of the established context, and (3) derivation of a metaphoric interpretation if the literal interpretation is found lacking. Ortony et al. assumed that by this model metaphor comprehension would require more processing time than comprehension of literals. They suggested that if metaphors were placed in lengthy contexts, comprehension time would not differ from literals. On the other hand, if metaphors were placed in short contexts they would require more processing time. The finding that long contexts eliminate processing time differences would negate the three stage theory of metaphor comprehension. In fact, Ortony et al. (1978) found that when metaphors were embedded in long contexts comprehension times were equivalent to those for literal statements. They explained this in terms of activation of relevant schemata. When metaphors are embedded in lengthy contexts, the numerous activated schemata provide the necessary context for metaphor comprehension. With shorter contexts, the number of activated schemata are fewer and consequently metaphor comprehension is slower than literal comprehension.

Inhoff, Lima, and Carroll (1984) essentially replicated Ortony's results. Inhoff et al. also showed that the reduced reading times of metaphors in long contexts are not due to reduced comprehension of metaphors. It is entirely possible that reduced processing time could come at the price of reduced comprehension. Inhoff et al. tested this possibility by including incomprehensible sentences in their passages. Reading times were not reduced for incomprehensible sentences even when embedded in long contexts. This indicates that increased context aids comprehension of metaphors.

Inhoff et al. questioned whether equivalent processing times indicated equivalent processes. They argued that one could obtain equal processing times if differing but equally time-consuming processes underlie both literal and metaphoric comprehension. They argued that priming metaphoric sentences with metaphoric contexts should reduce processing time when compared to literal contexts if the underlying processes are different. Results indicated that type of context was more important than length of context. Metaphoric context reduced reading time for metaphoric target sentences but not for literal targets. Conversely, literal contexts reduced reading time for literals but not for metaphors. Inhoff et al. explained these results in terms of schema theory. When metaphoric contexts were crossed with metaphoric targets or literals with literals there was more schema overlap than in the unmatched conditions. The main virtue of this explanation is that it ties metaphor comprehension research with mainstream reading research in which schema theory is dominant.

If metaphors are more vivid or they chunk information they should have positive mnemonic effects. Pearson, Raphael, TePaske, and Heyser (1981) found that metaphoric sentences were recalled better than literals when placed in unfamiliar passages, although overall recall was unaffected. Reynolds and Schwartz (1983) however obtained contrary results. They found that metaphors placed at the end of prose passages were recalled better than literal counterparts and that overall recall was also improved. Reynolds and Schwartz's metaphors served as summarizers which may explain their better overall results. Hayes and Mateja (1981) found that metaphors embedded in text produce greater engagement than comparative organizers. Subjects who read a passage with embedded metaphoric allusions produced more inferences and less incorrect information than subjects given a comparative organizer first. Because this same result was found with entirely different materials in an earlier study (Hayes & Tierney, 1980) they argued that the effect is reliable. Hayes and Meteja explained their results in terms of Mayer's assimilation theory of meaningful learning. According to Mayer (1980) there are three conditions for meaningful learning to take place: (1) the reception of new information, (2) an available familiar context into which to assimilate the new information, and (3) active use of this context. Hayes and Meteja pointed out that only condition three distinguished the metaphorical allusion from the comparative organizer since the other two conditions were satisfied in both treatments. In spite of these results, Becker and Carrier (1985) and Yarbrough and Gagné (1987) found that the insertion of multiple metaphors into a text did not increase learning. Both of these studies used many unrelated metaphors and thus do not speak the effect of a single root metaphor used to structure a body of content.

In addition to these studies of the the effects of metaphor on learning, there have been attempts to incorporate metaphor into a curriculum. Gordon's Synectics (1961, 1971) and Sanders and Sanders (1984) are examples of systematic approaches to the use of metaphor in instruction. Unfortunately, these approaches seem not to have been tested empirically. However, the empirical studies of Paris (1986) and Paris, Wixson, and Palincsar (1986) represent the apparent successful incorporation of metaphor into a reading program. In another field, Nichter and Nichter (1986) described how metaphors and analogies can be used in an international health education curriculum.

The studies on learning and metaphor have produced mixed results. When metaphors are embedded in long contexts and are combined coherently there appear to be beneficial effects on learning. However, when metaphors are not given sufficient context or are combined in a haphazard manner no positive effects on achievement have been observed.

## Recommendations for the Use of Metaphors

Based upon the above studies and others too numerous to cite in the limited space available, some recommendations for the instructional use of metaphors may be made.

(1) Use metaphors to explain concepts, principles, or procedures which are complex, unfamiliar, or abstract.

(2) Use metaphors to explain content if the learners are at least school-aged.

(3) Choose metaphors appropriate to the content and consider the affective connotations of the metaphors.

(4) When using several metaphors coordinate their meanings.

(5) Be sure the vehicle is familiar to the target audience.

(6) Consider the logical implications of each metaphor used.

(7) Consider whether it is obvious to the learner that the metaphor is not a perfect representation.

(8) Remember that metaphors are used to introduce an unfamiliar domain and be prepared to abandon them when the domain is well understood.

## Summary

There is a sizable body of research on metaphor. Recent studies have asserted the importance of metaphor in the creation of scientific knowledge. Although the substitutionist view of metaphor denies the necessity of metaphor, the vividness and concreteness of metaphors may give them educational importance. Studies of the comprehension of metaphor have not demonstrated any extra cognitive load and have generally shown positive mnemonic effects. Studies of analogies show that they, like metaphors, have a positive instructional effect with unfamiliar material.

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# USING ANALOGIES AS AN INTEGRAL PART OF INSTRUCTIONAL DESIGN

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## ABSTRACT

This paper presents the integral analogical design (IAD) model, a tactical instructional design model that uses analogies in an integral manner, that is, as the basis for a miniature learning system. This will be developed to show that it uses the latest in cognitive theory, is efficient and effective, and increases long-term retention.

## INTRODUCTION

Webster's definition--integral: lacking nothing essential

The use of analogies in instruction has much appeal--both from an intuitive point of view and from a cognitive science perspective. However, although numerous researchers support and suggest the use of analogies in instructional design, the use of analogies seems to be primarily ancillary; they are used in supplemental and supporting roles.

An analogy contains a powerful element: the ability to relate what is previously known to new learning. To date, no instructional design model uses analogies as an integral feature. This paper outlines a framework for such an instructional design model, reviews a related pilot study conducted by the authors, sketches the potential use of computers, and suggests directions for future research in the development of the model. It should be noted that this integral analogical design (IAD) model is really more of a design tactical model at this point in its development.

## COGNITIVE THEORY

Although a complete review of current cognitive theory is beyond the scope of this paper, a short synopsis of schema theory might be in order, because the theoretical notion of schema plays a powerful role in the use of analogies. Descriptions of schema vary slightly between authors, but the general idea claims that human memory connects and stores ideas in general structures referred to as schemata. These structures contain several notable characteristics. A schema holds variables for actors and their actions. These variables have expectations, or anticipated ranges of each variable. However, schema are not passive (Rumelhart, 1980). Rather, schemata are actively modifying their own structure through experience. This latter idea closely resembles Piaget's ideas of schema, assimilation and accommodation (LeFrancois, 1982).

These structures become "activated" during learning steps that rely on memory, such as recalling previous learning or understanding written passages. Schemata are used as the basis for comprehension, in that much of what we understand from reading a text passage is based on our own individual schemata. This accounts for different interpretations of similar events. Interested readers should consult the large body of literature on schema (see, for example, Bransford and Vye, 1989; Rumelhart, 1980; Schank & Abelson 1977; Norman, 1976; Mandler & Johnson, 1975). For our purposes, it is sufficient to accept that schemata are structures of organized information and that they play an important role in helping learners to interpret new information.

## USES OF ANALOGIES IN CURRENT MODELS

The most prevalent formal use of analogies in current ID models seems to be the suggestion for using analogies "early" in instruction (Stepich and Newby, 1987). Ausubel's classic work on advance organizers along with Mayer's work both suggest that analogies have a value when used as "ideational scaffolding," a way to suggest the structure of oncoming information (Mayer, 1984; Ausubel, 1968). Reigeluth's idea of an "epitome," in his creation of elaboration theory, can also be viewed as a variation of an advance organizer on a macro scale (Reigeluth & Stein, 1983). It would seem that an analogy could also function well as an epitome. Research results using advance organizers are sometimes contradictory; it seems that the exact nature of the to be learned information (among other variables) highly influences the effectiveness of an advance organizer (Jonassen, 1982).

## PARTS OF AN ANALOGY

Several authors have labeled the parts of an instructional analogy (see Curtis & Reigeluth, 1983 for a more complete history; Stepich & Newby, 1988). The names are not as important as the functions of the analogy, so for this paper we propose the following labeled components:

NEW LEARNING is like EXISTING KNOWLEDGE
(topic) (vehicle)

because ______ but not ______.
(limits) (grounds)

## HOW ANALOGIES WORK

Pelligrino and associates (1985) have suggested an explanation for analogical thinking, which consists of discovering relationships between the parts of the vehicle and then mapping those relationships onto new information. For example, if a novice rugby player was told only that rugby is like football, then the novice would be in a position of guessing at what portions of football rugby resembles. The novice might infer that both games use a ball (correct), that both have teams of players (correct), and that both use extensive protective equipment (incorrect). This obviously shows the value of delineating the limits and ground of an analogy. Such would be an "expositive" approach to analogical learning.

More important to our purpose, though, is the overall analogical reasoning structure--the discovery of relationships and the mapping on to new learning through inferences. Such a simple explanation, "rugby is like football" leads a learner to create his or her own hypotheses concerning why or how the two are alike. Our instructional design model then, should lead the learner to make explicit these hypotheses and then confirm or disconfirm their correctness.

## DISCOVERY LEARNING

Bruner's classic series of experiments on concept aquisition through discovery methods illustrate that a basic discovery approach to learning is possible (Bruner, Goodnow & Austin, 1956). The advantages of discovery learning are often debated, but in general one can say that discovery techniques are more motivating, involve the learner in the learning process, promote thinking skills, and lead to superior retention.

## SIMPLE MODEL

Our most basic model of integral analogical design (IAD) consists of four major steps.

1. Determine that the student has rudimentary knowledge of the vehicle of the analogy, i.e., assess the student's schema.

2. State the analogy, with very few limits and grounds.

3. Require the student to explicitly state what he or she believes to be valid inferences concerning the new learning.

4. Confirm or disconfirm with corrective feedback.

The model follows a discovery approach similar to Bruner's in that it enables the students (assuming an adequate schema) to create and test hypotheses. One may also notice a cybernetic approach to the model as the student constantly approaches the goal, guided by feedback.

A variation on this model would leave steps 1 and 2 untouched, but would replace steps 3 and 4 with:

3. Ask the student questions that guide him or her into inferring the correct answer.

4. Confirm or disconfirm with feedback.

This variation gives the designer much more control over the direction of the students' hypotheses and would fall under the "guided discovery" label.

## PILOT STUDY RESULTS

In an attempt to judge the strength and usefulness of the integral analogical design (IAD) model, we conducted a pilot test in early 1989. We were specifically interested in testing two important assumptions behind the model: (1) the ability of the learners to use the embedded analogy to "discover" or infer new knowledge that was not specifically presented in the text; and (2) the need for a highly developed vehicular schema to learn from analogies. We were also interested in analyzing the appropriateness of these assumptions for both short and long term retention.

Sixty undergraduate subjects were given a questionnaire to determine knowledge areas in which each might have a suitable (well-developed) schema. Several weeks later, using a counterbalanced design and Latin square arrangement (Campbell and Stanley, 1963), each subject was administered a series of three short text passages containing analogies of varying degrees of familiarity. These were labelled "individualized" or "generalized" analogies, depending on each subject's degree of knowledge of the vehicle of each analogy. A "no analogy" treatment was also administered. The topic of each text passage was based on fabricated subject matter to control for prior knowledge. Students were given a immediate post test (IPT) asking a series of questions relating to the text passages. Some questions required rote recall from the passage; other questions forced the student to infer the answer--the answer was not given in the text. Approximately 2 weeks later, a delayed post test (DPT) identical to the IPT was administered. At this time, the questions were asked again, without the text passages, to measure retention over time. Of the sixty original subjects, 17 were lost due to absence from any of the testing sessions, leaving 43 final participants. (see results table 1.1)

The results show that the model apparently works to a degree, that is, learners can learn from instruction designed from this model. From repeated measure t-tests of our second hypothesis, no significant differences were apparent between individualized and generalized groups. A few formative interviews showed that learners with a highly developed schema regarding the vehicle of the analogy may have spent additional time pondering the situation and attempting to incorporate the new knowledge into a complex existing schema. This might suggest that individualized analogies are not the most efficient vehicles for this model, since the integration of the new learning requires major accommodation of existing schema. This suggests that a generalized analogy--a vehicle that is commonly known but not at an expert level-- is the best vehicle for an analogy in this model. Interestingly, the "no analogy" group scored much better than anticpated. This unexpected high scoring may be due to the fact that well over half (26) subjects correctly identified the analogy on which the passage was based--even though it was never given in the passage. Obviously, we cannot tell whether these subjects used a form of analogical reasoning or not, but their high scores and correct identification of the analogy would make us assume that many of them did in fact use a form of analogical reasoning, hence the high scores.

Also of significance is the fact that over time, the fact level information was forgotten to a much greater extent than the inference information. This forgetting was significant ($p<.001$) in every group. This would imply that the power of such a "self-discovery" instructional model would aid long term retention of material.

## CONSIDERATIONS

The integral analogical design model has weaknesses, the most obvious being that not all subject matter will map for very long with an analogy. Recall our earlier football and rugby example. While the two share several parallel features, and one can be mapped onto the other quite well, inevitably, the two topics will reach a point where the analogy no longer works. We must make sure that this point is not reached until the learner's new framework (scaffolding) of the topic is developed well enough to continue without the help of the analogy. Selection of an analogy therefore, needs to be made carefully considering both the "parallel-ness" of the two subjects as well as student knowledge of the vehicle topic.

## ROLE OF THE COMPUTER

Thus far, our discussion has been media free. That is by choice; our intention was to create a design model that would function independent of media constraints. But, such a cybernetic model lends itself well to interactive computer-based learning systems. For example, the computer could be used in the process of matching potential vehicles to learners' existing knowledge. This could be done via a computerized diagnostic pre-test which could determine the strength of a learner's schema regarding various vehicles. These potential vehicles could then be evaluated as to appropriateness of "parallel-ness" for use within a lesson. It should be noted that "lessons" in the integrated analogical design model are extemely short and dense--perhaps not more than a paragrpah or maybe as short as a sentence.

Also, the computer could be used to guide the learner's discovery of the attributes of the topic. This all-important feedback function is a natural for the computer.

## FUTURE RESEARCH SUGGESTIONS

While our initial pilot study determined some interesting insights into the model, further research using such a model is in order. A more valid method of determining existing schema is needed. Suggestions and possibilities include free word association and/or pattern noting, which are both possible via computer (Jonassen, 1987; Preece, 1976).

An interesting variable that also requires further study is the skill of analogical reasoning. It is possible that the integral analogical design model will only work with students who are strong analogical thinkers, that is, already skilled in the act of analogical reasoning. It is also possible that use of the IAD model could strengthen the skill of analogical reasoning.

An important extension of this research will be to test the effect of providing feedback as indicated in step four of the IAD model. This was one element missing from our pilot study.

Also of importance to the IAD model is the idea of generative strategies. Wittrock (1974) developed a model of generative learning which proposed that for meaningful understanding to occur, the learner must be an active participant in the learning process. Following his thinking lends much theoretical support to the IAD, but also raises some additional research questions. First, with the IAD, the learner through active mental inferencing constructs connections and meaning from the passage. While this is true, a further question arises as to the fact that the learners may be more mentally engaged if they selected or constructed an appropriate analogy themselves. Testing the utility and effectiveness of this variation will be important to the development of the model.

Second, analogies, in and of themselves, may "cause" active mental engagement, and, therefore, eliminate the need for the less efficient method of discovery through analogies. This possibility calls for research that tests the effectiveness (as measured by mental engagement) of discovered vs. explicit (supplanted) connections between the vehicle and the topic. This research may provide us with important insights into the utility of supplantation strategies for those learners with less developed analogical reasoning.

## CONCLUSION

We have attempted to outline integral analogical design (IAD), a potential instructional design tactic based on current theories of human memory and cognition. We have attempted to use schema theory to create a new instructional design model that will captialize heavily on a student's previous knowledge, on discovery techniques, on improving long-term retention, and on efficient and effective learning of text material.

## PILOT RESULTS (TABLE 1.1)

| | IPT | | DPT | |
|---|---|---|---|---|
| | INFER | FACT | INFER | FACT |
| IND. | 1.90 | 2.48 | 1.88 | 2.04 |
| GEN. | 1.97 | 2.44 | 1.88 | 2.16 |
| NO | 1.81 | 2.46 | 1.72 | 2.16 |

IND= individualized analogies
GEN= generalized analogies
NO= no analogies

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# EVALUATING INTERACTIVE COMPUTER SYSTEMS

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## ABSTRACT

Six dimensions of overall reaction to using a computer system were evaluated by 92 college students. Two computer systems were compared: the Apple Macintosh and the Grolier Electronic Encyclopedia. Students thought that the Macintosh was significantly more interesting and significantly more stimulating than the Electronic Encyclopedia.

## EVALUATING INTERACTIVE COMPUTER SYSTEMS

Understanding successful human-computer interaction (HCI) means discovering what human characteristics are involved in learning to use (National Research Council, 1983, p. 114). Educational researchers tend to concentrate on achievement as the single dependent variable. It can be useful when comparing instructional techniques but may not be informative about either cognitive or social processes. The achievement measurement strategy would be especially inappropriate if applied to successful mastery learning. These situations show no important differences in performance outcomes because all students have learned to a specified standard. These mastery learning situations are also typical of HCI in education and training. Towards better understanding of HCI, human aspects of quality also need assessment.

The purpose of this investigation was to examine the impressions of students using interactive computer systems. Six dimensions of overall reaction were identified for subjective evaluation purposes by Shneiderman (1987, p 401). To enable comparison of these dimensions, college students were given two different computer systems to learn. After their learning experiences they rated the six dimensions of overall reaction on survey questionnaires. They were also asked to add written comments. No hypotheses were stated a priori and the results are intended to be suggestive, an approach Marchionini found productive (1989).

## METHOD

Respondents were 92 college students enrolled in introductory instructional technology classes. The contents of the questionnaire were six dimensions of overall reaction to using a computer system: terrible / wonderful, frustrating / satisfying, uninteresting / interesting, dull / stimulating, difficult / easy, and inadequate power / adequate power. These were evaluated by the students on numerical scales from 0 through 10. A does not apply option was available on the right of each scale as the initials NA.

Two interactive computers systems were compared. These were the Apple Macintosh microcomputer and the MS-DOS version of the Grolier Electronic Encyclopedia. Macintosh was a long learning to use experience compared to the

Electronic Encyclopedia learning to use experience. The 47 Macintosh students had 12 hours of learning to use Macintosh for word processing (MacWrite) and graphics production (MacPaint). The 45 Electronic Encyclopedia students accessed the Grolier Electronic Encyclopedia. They used the KRS interface on a Zenith MS-DOS machine to conduct a search and print out at least one article. All students met mastery learning criteria. They circled the numbers on the survey form immediately after completing their learning experiences.

## RESULTS

Although Macintosh was rated more positively overall than the Electronic Encyclopedia, the results indicated that students' sum impressions were not significantly different between the two computer systems. T tests showed differences on two dimensions. Macintosh was significantly more interesting ($\underline{M} = 9.38$) than the Electronic Encyclopedia ($\underline{M} = 8.48$), $\underline{t}(86) = 3.24$, $\underline{p} < .01$. Macintosh was significantly more stimulating ($\underline{M} = 8.88$) than the Electronic Encyclopedia ($\underline{M} = 7.57$), $\underline{t}(83) = 3.21$, $\underline{p} < .01$.

## DISCUSSION

Determining quantitative findings like these can add meaning to open ended comments. For example, students evaluating Macintosh wrote: "This is an interesting system to learn. The diversity of options is remarkable." "With more time and a Mac near me I think I could be in love." Students evaluating the Electronic Encyclopedia wrote: "It was very easy to use, and appropriate for everyone who needs to do a report or research something." "Found it very easy to do. By the second time hit and miss I had it down and was impressed with how self explanatory it was." Although qualitative commentary has a richness of its own that should not be ignored, quantitative scaling has value for making comparisons between interactive computer systems.

## CONCLUSION

The relationship of learners' impressions to their computer experiences is often ignored as a moderator variable, secondary to achievement. However, with mastery learning situations commonplace when interacting with computer systems, the full range of human factors needs evaluation towards understanding HCI. Examining overall reaction on subjective scales contributes useful information about the instructional aspects of HCI.

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# USING A COMPUTER-BASED AUDIOGRAPHIC TELECOMMUNICATION SYSTEM FOR DISTANCE LEARNING

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## Abstract

By combining the use of an existing teleconferencing network with new computer-based video technologies, the University of Wyoming has enhanced its ability to provide educational opportunities for students at remote sites across the state. The new computer-based audiographic system was tested during the fall semester of 1988 during the delivery of a course in visual literacy. Course development concerns included: 1)maintaining consistency between on- and off-campus sections of the course, 2) humanizing the delivery system, and 3) dealing with unique instructional design and delivery demands which emerged from the use of the technologies. Some of the suggestions for the design and development of similar courses using a computer-based audiographic telecommunication system inlcude: 1) acknowledging capabilities and limitations of the delivery system, 2) reducing technophobia, and 3) cautioning students and instructors of the time, flexibility, and energy demands of the delivery system.

## Introduction

Distance education is characterized by interaction among a teacher and learners who are separated geographically but who communicate using various delivery modes and diverse types of mediated technology to accomplish course objectives. Distance education, enhanced by newer technologies, has opened doors for reaching larger and more diversified groups of learners who have not been served by traditional on-campus courses. In Wyoming, a state with one four-year university serving students in remote communities, distance learning has become a viable approach to continuing education. Extended learning opportunities have been available to distant learners in Wyoming for many years, though funds have been limited. By incorporating an existing audio teleconferencing system, the recent addition of computer-based graphic capabilities has greatly expanded the ability of the University of Wyoming to meet the needs of distant learners. This paper summarizes successes and frustrations experienced in the design and delivery of the first course offered by the University of Wyoming using the new computer-based audiographic telecommunications system and offers suggestions to users of similar systems.

## Technological Support Available for Distance Learning

The University of Wyoming has a history of providing correspondence study for remote learners. Face-to-face instructional opportunities also are made possible by transporting faculty members to locations across the state. Additionally, a state-wide audio telecommunication network was established in the mid 1980's, enabling instructors to remain on campus while working with students in remote locations. In 1987, a video classroom was built from which selected courses were videotaped and the tapes were then mailed to students at selected sites. Budget constraints have precluded the use of satellite or microwave technologies to date, and a means of best utilizing the existing audio telecommunications link and video facilities was sought.

A computer-based audiographic system which incorporated existing audio technology was set up and tested at three locations during the fall of 1988. The systems used at three sites (Laramie, Rawlins, and Douglas) consisted of an Epson computer with a portable hard disk drive storage system, two monitors (one RGB for video images and one composite for graphics ), a 1200 BPS Voice-Too modem by Optel, Telewriter 3-PC software with an Image Capture Board (ICB), an electronic penpad, and the audio teleconferencing phone link. With the Voice-Too modem only one phone line was necessary for simultaneous transmission of both data and voice. Laramie was the base site with the instructor directing the other systems, though Rawlins or Douglas could also control the systems, as needed.

The computer-based audiographic system was established because of its potential to be used interactively by participants at all three sites. Audio teleconferencing provided voice interaction while the graphic tablet/penpad and keyboard allowed for limited real-time visual feedback and interaction. Video images previously captured on the hard disk and mailed to the sites were "called up" and used during audio teleconferencing. Unfortunately, the transmission of real-time still-frame video images required capabilities beyond those of the current system and this option was not available.

## The Course to Test the System

An introductory course in *visual literacy* was chosen as the first class to be delivered on the computer-based audiographic system. The content of the course itself was one factor influencing this decision. A course in visual literacy, appropriately enough, required a great number and a wide variety of instructional visuals. Course designers wanted to test the limits of the system to provide visual/graphic interaction among students and the instructor, and this course demanded a great deal from the technologies. A second factor influencing the decision was that the instructor taught courses in the instructional technology program area and was personally interested in testing the technology. Since the visual literacy course was offered for credit in instructional technology, many of the students who enrolled also shared a curiosity in the computer-based audiographic system. Another consideration was that the visual literacy course was being taught on-campus during the same semester it was taught off-campus, providing an opportunity to compare the two courses.

In addition to the computer-based telecommunication system, instructional support for the delivery of the visual literacy course included print materials, 16mm film, slides, and videotapes which were mailed to the two sites where classes were held. A facilitator not enrolled in the course was employed at each class location to oversee the distribution and use of these materials and to monitor the system. A FAX link was established toward the end of the course which also enhanced the transmission of information among sites, but the students and instructor were not able to use the FAX link to communicate directly.

## Course Development Concerns

In developing the visual literacy course for delivery via the computer-based telecommunication system, the instructor had three primary questions: 1) how can this course maintain as much consistency with the on-campus course as possible? 2) how can this course be as *human* as possible? and 3) how will the preparation and delivery demands differ from an on-campus course?

### Consistency

The instructor of the course was committed to designing an off-campus version of the visual literacy course which was the equivalent of the on-campus section in every aspect possible. Course goals, specific objectives, course requirements, and grading criteria were identical for both sections. Though the sequencing of the content was similar, scheduling modifications were necessary in the off-campus version of the course. Students were asked to submit numerous visual assignments, and time was needed to receive off-campus students' work in the mail, transfer the images to videotape, capture the still-frame video images onto the portable hard disks, and return the disks which contained the captured images to the class sites so the assignments could be viewed and discussed.

It might have been feasible to have students at each individual site view and discuss the "local" class projects, but neither the instructor nor the students at the other locations would have shared in the dialogue. The instructor chose to make modifications in the course schedule so that all of those enrolled off-campus could view the work of the other off-campus participants. Though this procedure required students to submit work and then wait for periods of up to two weeks before discussing the assignments as a group, students did not mention this logistical manipulation as a weakness of the course.

### Humanizing the Technology

A major concern of the instructor was how to maintain as much *high-touch* as possible while using a relatively *high-tech* delivery mode. One strategy was to mail a short biography and photograph of the instructor to students prior to the class in order to provide "a face to go along with the voice" of the instructor. During the first class session, students used the graphic capabilities of the system to draw self-portraits or other visuals to help introduce themselves to other class members, and the instructor did the same. Students were required to produce self-portrait collages composed entirely of visuals which were shared in class, and the instructor also produced a collage and participated in the discussion. This activity encouraged interaction and helped both students and the instructor realize that *real people* were actually involved in the distance learning experience.

Another concern relating to the *human* factor involved in the computer-based telecommunication course was how to provide students with feedback from the instructor and, conversely, how the instructor could receive feedback from students. During the development of the course, the instructor had hoped both visual and verbal exchange would be possible. Unfortunately, the capability of the system to transmit visuals in real time was extremely limited. Slow-scan image transmission required almost 15-20 minutes to complete and audio interaction was impossible during this period. Therefore, the instructor used the audio component of the system, the computer keyboard, and the graphics tablet/ penpad to encourage interaction and feedback during class. Though visual feedback was possible by using the computer keyboard or the graphics tablet/penpad, students usually verbalized rather than visualized their questions and comments. Students both solicited feedback from the instructor and responded to the teacher's requests for information primarily using the audio mode. In retrospect, students indicated a greater familiarity and comfort level with the microphones than they did with the computer. In future courses taught using this system, the instructor will allow more time for students to become familiar with the computer-based technology and will require students to use the visual communication capabilities of the computer-based system more frequently.

### Preparation and Delivery Demands

In preparing and delivering the course using the computer-based audiographic system, the instructor found that time, flexibility, and energy level were the three key factors affecting the successes or problems with the course from week to week. Although the design and development of the course was complete prior to the beginning of the semester, preparing for weekly three-hour sessions was extremely time consuming. The instructor initially devoted personal time to learn and then to review basic operation of the computer-based delivery system. Although computer-generated instructional visuals were produced by others, the instructor was responsible for designing and/or requesting visuals and other materials at least two weeks in advance. Though this procedure encouraged advanced organization and structuring of the course, it required a great deal of pre-delivery planning and inhibited spontaneous modifications.

Using the computer-based audiographic system also required a great deal of flexibility on the part of the instructor. As indicated above, it was difficult to make spontaneous changes or to provide additional information, especially if visuals were required, so the instructor had to think of alternative instructional approaches or examples which would work within the constraints of the system. The graphics tablet/penpad proved to be the communication medium most helpful to the instructor when real-time visual examples were needed, but the audio link proved to be the most flexible medium to use during the delivery of the course.

The computer-based telecommunications system also required another type of flexibility on the part of the instructor. During the semester various problems with the technologies were encountered: the computers at one location or another would go down or fail to boot, a faulty disk would be discovered, the audio transmission would be garbled, or the telecommunications link would be lost. Technological quirks demanded flexibility — and patience — on the part of both students and the instructor.

The most unexpected demand upon the instructor was the high degree of energy required to actually deliver the course each week. In addition to the traditional efforts associated with delivering instruction, the computer-based audiographic system required the instructor to use the technology effectively as well. Turning the microphone on and off, switching the computer from keyboard to graphics tablet/ penpad mode, or calling up the correct pages of computer graphics from the hard disk were tasks to be accomplished while delivering course content. Though the demands associated with using the technology eventually might become less obtrusive over time and with practice, this was not the experience of the instructor. The instructor felt that two levels of functioning were required — an awareness of what was being said regarding the course content as well as an understanding of how to manipulate the technologies in order to deliver the information. These endeavors required not only a great deal of planning but a great expenditure of energy as well.

## Capabilities and Limitations of the System

In retrospect, the computer-based audiographic telecommunication system did provide an opportunity to offer a course to distant learners which would not have been possible without the visual/graphic capabilities provided by the computer. Although the particular system used was relatively elementary, it enabled the exchange of visual information which was necessary for a *visual literacy* course to succeed.

Though the process was cumbersome and time-intensive, students' visual projects and instructor-selected materials could be captured on hard disks and distributed for viewing and analysis. The graphics tablet/penpad could also be used while the visuals were being displayed on the computer monitor so that specific areas of an image could be pointed to or marked on the screen.

A degree of visual interactivity did exist among students themselves and the instructor, but as discussed previously, real-time visual exchange was limited. A further frustration was the quality of images captured on disk. Details were often difficult to see when viewing an entire image, and when close-up shots were taken visuals lost much of their impact. Monitor resolution was not high, and more monitors or a larger monitor were needed at the sites for students to be able to view the visuals efficiently.

In terms of the audio component of the system, the major limitation was that when the computer-based component of the system was in use, transmission noises interfered with audio quality. When visual/graphic capabilities of the system were utilized, audio transmission was unavailable, precluding simultaneous visual/verbal instruction. Two other limitations of the system surfaced in students' evaluative comments. First, students were concerned that they could not see the instructor. This uneasiness mirrored the instructor's concern over not being able to give or receive visual feedback, as discussed above. Second, student comments reflected a high degree of discomfort in actually using the technology to interact with fellow students and the instructor. Students were intrigued by the experience of receiving information via a computer-based audiographic system but indicated that using the system inhibited them and at times discouraged them from participating in class. These technophobic tendencies may have been lessened if the students had more opportunity to experiment and interact with the technologies.

## Suggestions and Caveats

Based upon the evaluations from students, instructor, administrators, and support staff, the following recommendations and considerations are offered for those planning to use a computer-based audiographic system to provide distance learning opportunities.

***Build on practices and procedures which have worked before.*** Literature on distance education and telecommunications offers numerous guidelines for conducting successful learning experiences with individuals located at diverse sites. While suggestions such as calling on individuals by name to answer questions, using teaching methods such as panel discussion and group work to encourage on-site interaction, and conveying personal enthusiasm may seem elementary, remembering the basics were important for the instructor when using the computer-based system. Allowing adequate time for students at each site to discuss questions and respond was difficult for the instructor who was unable to see if students were actually working on the problem. But *wait time* became extremely important when students were formulating answers without the aid of visual cues from the instructor.

Another lesson learned by the instructor was the importance of directing students to talk to each other rather than through the instructor. Students at the two sites tended to avoid direct communication with each other and would respond to other class members' comments by addressing the instructor rather than speaking directly to their peers. Once this tendency was pointed out, students began to dialogue with each other, which helped make the technology more transparent by increasing the sense that other *real people* were involved in the class.

Finally, feedback remained a concern for both the instructor and students. The instructor found that important points had to be repeated or reemphasized more frequently than during on-campus courses. Main ideas needed to be restated frequently by students or the instructor in order to check on the accuracy of the information received. The instructor also needed to solicit feedback about pacing, audio clarity and volume, resolution and clarity to visual images, and problems associated with the operation of the technologies. Furthermore, the instructor found that some students who were uncomfortable asking questions in class appreciated the opportunity to contact the instructor individually by phone with questions or concerns. Though this procedure required more time and energy on the part of the instructor, it added to the success of the course. Incorporating basic guidelines for the delivery of telecommunications courses aided the instructor in using the computer-based audiographic system.

***Combat technophobic reactions.*** Though many of the students involved in the course were interested in taking a course using the computer-based system, numerous students expressed discomfort when actually using the technologies. Using the microphones was disconcerting and students worried when working with the computer-based graphics tablet/penpad or keyboard. Though efforts were made to introduce and familiarize students with the operation of the technologies, additional emphasis will be placed on acquainting students with the hardware in the future.

Since only one computer-based system was available at each location, students had limited opportunities to use the system. Additional systems would provide greater opportunities for students to use the technologies and would also enhance the ease with which students could view information being displayed on the computer monitors. Students might also be given time outside of class to experiment with the capabilities of the technologies. And students could be encouraged to use the system by requiring each individual to respond more frequently in class. Although assignments required each student to use technologies at times, individuals at each site emerged who tended to assume responsibility for responding for the group. This proclivity for a group spokesperson to emerge could be redirected by assigning a different student each week to be in charge of relaying group responses. Students supported each other in their efforts to use the technologies and could be encouraged to help their peers become comfortable with the computer-based system.

***Consider using all available delivery resources***. Although the computer-based audiographic telecommunications system was the backbone of the delivery system, the course would not have been feasible without the exchange of assignments and information through the mail and via FAX transmission. Hard disks, print materials, 16mm film, videotape, slides, student assignments, and evaluations all required surface delivery. One comment made by students was that more concrete examples of projects rather than video reproductions would have been helpful, and these could have been supplied through the mail. The FAX link was invaluable in transmitting last-minute information among sites and will be utilized more frequently in the future. As stated above, many students found private telephone contact with the instructor beneficial. Supplementing the computer-based system with additional delivery resources enhanced the course and extended the options available to students and the instructor for interaction during the class.

***Emphasize the high-touch — the high-tech is apparent***. The transparency of the technology may affect students' acceptance and use of the hardware utilized to deliver courses and may subsequently influence the learners' attitudes toward the course itself. The instructor found that students were quite aware of and sensitive to the use of novel technologies, but by placing emphasis on the interpersonal aspects of learning and instruction, students were encouraged to look past the delivery system and focus on course content. Collaborative group assignments, calling on individuals by name, having students describe themselves and their environment, talking informally with students during breaks or on the phone, sharing visuals, telling jokes or talking about the weather at different sites, and encouraging participants to interact as much as possible were all strategies used to underscore the fact that the technologies were just being used to help *people* communicate more efficiently. If involved in a course using the computer-based system again, the instructor would like to travel to individual sites and teach once from each location. Strategies such as these may enhance the *human* aspects of the course and lessen student concerns over the delivery system itself.

***Consider time, flexibility, and energy requirements***. These three factors heavily impacted the instructor. And, to some degree, these factors affected the students involved in the course as well. Both students and the instructor should be advised prior to making a commitment to a similar course of the time expenditures projected, the patience and flexibility often demanded by the use of technologies, and the energy levels necessary to foster a successful distance learning experience. The demands of participating in a course delivered by the computer-based audiographic system were greater for the instructor in terms of time, flexibility, and energy than were the demands of teaching the same class on campus. Other individuals involved in establishing and maintaining the off-campus program also contributed significantly in terms of time, energy, and effort. However, based upon student, administrator, instructor, and staff evaluations, the expenditure of energy resulted in the effective use of the computer-based telecommunications system to deliver a course to interested, appreciative learners.

## Summary

Both obstacles and advantages are inherent in distance education and the use of a computer-based audiographic telecommunication system. In developing a course delivered by a computer-based audiographic telecommunication system, the instructor initially was concerned about maintaining consistency between the off-campus version of the course and the on-campus section of the class, emphasizing the *high-touch* aspects of the course while using a *high-tech* delivery mode, and meeting any additional preparation and delivery demands imposed by the use of the computer-based telecommunication system. Though limitations to the use of the technologies surfaced and

the instructor's concerns were justified, use of a computer-based audiographic system proved effective in delivering a course in *visual literacy* to remote sites. Suggestions for using similar computer-based systems include: 1) follow general heuristics for the delivery of courses via telecommunications systems, 2) reduce technophobia, 3) use all available resources to communicate, 4) emphasize the *human* aspects of the course, and 5) be cognizant of time, flexibility, and energy requirements demanded by the use of the technologies. Success and frustrations experienced in the design and delivery of a course using a computer-based audiographic telecommunication system suggest that the use of these technologies has increasing potential for assisting in the delivery of future courses to distant learners.

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# COMPUTER-AUGMENTED TEACHING: PERSPECTIVES AND PROBLEMS

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For centuries teachers have attempted to increase understanding through use of visual images. That such visuals are beneficial to learning is a commonly accepted precept. Yet it is rare for a computer to be used as a teaching aid in a university classroom. This paper explores the potential of Computer-Augmented Teaching (the use of computer graphics to enhance lectures) and presents the author's experience in developing graphic software and adapting it to an upper-division statistics course.

Limited budgets have inhibited adaptation of the computer to the lecture hall. Screen sizes over thirty inches and resolution sufficient for CGA graphics or better are required and can be quite expensive. The cheaper LED adapters for overhead projectors fail in color quality and contrast. True screen projection systems with resolution exceeding VGA are available but are priced from $11,000 to over $100,000.

The general orientation of both authoring systems and applications toward a one-on-one teaching situation is another obstacle. The author points out the substantial differences between software designed for Computer-Augmented Teaching (CAT) and that intended for Computer-Assisted Instruction (CAI).

The author's learning modules for the sampling distribution and areas under the normal curve will be presented.

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# Project QUEST and the Informal Development of Computer-based Instruction

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Project QUEST is a long-term effort of the University of Texas at Austin to increase the innovative use of microcomputers in teaching and research. It is supported in part by gifts of microcomputer hardware and software from donor companies. Periodically, faculty members are invited to submit proposals for innovative use of the donated systems. Specific guidelines are defined for the proposals, which are reviewed by a seven-member faculty committee for award of hardware and software as distinct faculty projects. Projects are systematically reviewed, and the allocated equipment is transferred to the departments of those projects successfully attaining their objectives. Since April 1984, 1250 IBM systems and 175 Macintosh systems have been awarded to 421 faculty projects.

Providing only hardware and software to faculty has nonetheless produced some interesting results in developing computer-based instruction. Over 70% of the projects are related to innovative use of microcomputers in teaching, with more than half of these developing original software. An informal approach has been followed for development, in which the faculty member either does his/her own programming, or else works directly with student assistants supported by funds external to QUEST. While several software packages have been made available through Wisc-Ware or Kinko's, most development has been to meet specific teaching objectives for a project, and not necessarily for academic or commercial distribution.

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# Evaluating Instructional Software:

## More Than a Checklist

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Within higher education settings, the formative evaluation of instructional software has long been prescribed but seldom systematically practiced. Faculty software developers tend to work independently (particularly with the availability of authoring tools such as Hypercard, CALIS, and Course of Action) and are seldom familiar or experienced with formative evaluation methodologies. They tend to function as if subject matter expertise is sufficient grounds for predicting the program's instructional validity and usability. Even when a team approach to software developments is practiced, systematic formative evaluation tends to get neglected.

Within this presentation we will:

- discuss strategies for encouraging and supporting faculty and other instructional software developers in designing and conducting formative evaluations.

- describe and demonstrate four evaluation approaches that the presenters have used for collecting information to direct improvement and revision efforts: Read and Think Aloud, Paired Critique, Printed Screen/Noted Reactions, and Videotaping.

- discuss the pros and cons of each approach and propose guidelines for selecting an appropriate evaluation strategy based on: a) the particular phase of software development; b) the attributes of the software and its design; c) available expertise and resources; d) personalities; and e) the political climate of the project.

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# INSTRUCTIONAL COMPUTING RESOURCES
# FOR HIGHER EDUCATION

Carol A. Dwyer* - Penn State University

Many higher education institutions have personnel who, informally or formally, assist faculty and staff who are trying to enhance the instructional process through the use of computers and related technology. Access to up-to-date information and current resources is requisite to successfully serving others in this capacity.

This presentation will provide an overview of a database which is under development by the author at the Computer Based Education Laboratory of Penn State University. The database contains information about resources which can assist in finding, evaluating, and developing instructional software for use in higher education.

The database includes:

1. software clearinghouses,
2. sources of information about award-winning software and innovative applications,
3. organizations which focus on technology in education,
4. conferences on use of technology in education,
5. cooperative ventures to assist integration of technology,
6. videotapes about software and interactive video, and
7. publications related to using technology for instructional purposes.

Database fields include a description of the resource, cost, and where to find it. The database will be available in hard copy and, by specific request, on disk.

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# AUTHORING SYSTEMS REVISITED

CRAIG LOCATIS AND VICTOR CARR

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Authoring systems allowing people to create computer-based instruction without programming are one of several approaches for developing CBI. The authors surveyed and evaluated these systems several years ago and the results were presented at ADCIS in 1984. This update features a brief review of authoring system selection methods and focuses on current trends in authoring system development and use. The utility of authoring systems is addressed.

More authoring systems have appeared since the authors reviewed them, but many have not survived the market. Although authoring systems have changed, the selection procedures and criteria that were identified in their previous study are still relevant. Other, similar selection criteria have been proposed and reviews of authoring software are appearing regularly in the literature. There are more authoring system users and sources of information for making rational choices. These information sources and circumstances where authoring systems might have appropriate utility are described.

When the authors conducted their initial review, they predicted a market shake out and a movement from "conventional" authoring software for "traditional" CBI to more "intelligent" authoring aids generating more "intelligent" instruction. The validity of these predictions is addressed and anticipated and unanticipated advances in the development of authoriing software are discussed.

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# EMERGING INTERACTIVE DESIGNS IN THE HEALTH SCIENCES

CRAIG LOCATIS, VICTOR CARR, MICHAEL WEISBERG

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New instructional designs -- scenario-based instruction, hypermedia and parallel systems -- are emerging in health professions education that are very different from previous interactive computer-based instruction. Video demonstrations of programs showing these designs are presented. The programs and design approaches are discussed and contrasted with more traditional categories of CBI design-like drill and practice, tutorial and simulation.

Scenario-based instruction involves embedding teaching programs in a situation or story that may or may not resemble reality. Learners interact with the scenario and the success of their interaction depends upon having mastered the concepts taught in the program. Didactic lessons teaching these concepts may be accessed optionally or imposed by the system depending on performance. Hypermedia programs provide rich knowledge-bases and tools for information retrieval and exploration. There are high levels of learner control and little performance assessment and monitoring. Parallel systems provide a corpus of knowledge and many modes of interacting with it. For example, a computer-based advice system, or job aid, may have additional components that teach the content in its knowledge-base or that provide additional information.

These new approaches to learning tend to be information and knowledge-based. They are cognitively oriented and generally provide higher degrees of learner control. Their successful use in teaching depends upon the nature of the learners and design quality. The conditions where these approaches might be appropriately used are outlined and design decisions for maximizing their effectiveness in teaching are discussed.

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# THE MODEL CLASSROOM AT PENN STATE

Lawrence C. Ragan* - Penn State University

The "Model Classroom at Penn State" project was designed to demonstrate the use of computer technology as a tool to develop and deliver instructional materials in the college classroom. This project is a cooperative effort between Apple Computer, the Center for Academic Computing, the College of Agriculture, and the Computer Based Education Laboratory at Penn State. The course selected to demonstrate this state-of-the-art use of technology was Animal Science 1, an introductory course for agriculture majors.

Three major phases have been identified for the project:

- PHASE I: INSTRUCTIONAL MATERIALS DEVELOPMENT AND DELIVERY: Emphasis on the development and presentation of information in the classroom in a multi-media format including HyperCard and interactive video.

- PHASE II: STUDENT SUPPORT MATERIALS: Emphasis on the development of instructional modules for student use to augment lecture information.

- PHASE III: LAB EXERCISES AND SIMULATIONS: Emphasis on the development of simulations for laboratory experiments and supporting exercises including animal nutrition studies and dissection experiments.

This presentation will focus on the identification of project objectives, procurement of resources, courseware development and delivery processes, and project evaluation to date. Software considerations, presentation and projection systems, and project management will also be discussed.

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# Learner Control: Implications for Research and Practice

Rowena S. Santiago - The University of Georgia

James R. Okey - The University of Georgia

The growth of computer-based education (and more recently, hypermedia), has renewed the interest in learner control of instruction. Many computer-based lessons include provisions for learners to make decisions regarding their own learning (sequence, amount of practice, when to test, etc.). Designers, therefore, have responsibility for providing sufficient and effective instruction with the right amount of control for learners.

Research studies have identified conditions that relate to the use of learner control in instructional design. These conditions include: learner characteristics (particularly, ability, motivation, and metacognitive skills); instructional objective and content; and instructional media used. Differing amounts or levels of control have been studied with various sets of conditions. Outcomes of studies done have been reported in terms of the effectiveness, efficiency, and appeal of control in the design of instruction. Both consistent and conflicting findings are found in the literature but little has been reported with regard to emerging patterns of relationships between conditions identified, instructional designs used, and outcomes.

The purpose of this paper is to look closely into the findings from learner control studies, synthesize them to identify emerging patterns, and give their implications for both practice and research. A focus of the paper will be on information needed by learners to make effective control decisions and the role of metacognition in self directed learning.

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# DESIGNING A COMPUTER-MANAGED TESTING SYSTEM FOR A MICROCOMPUTER NETWORK

James T. Talley - The Ohio State University

Running a traditional computer-managed testing system on mainframe computers can be expensive, particularly when the number of students taking tests is small. Using stand-alone microcomputers for testing can quickly lead to problems with test security, data integrity, and data collection. A computer-managed testing system designed for a microcomputer local area network (LAN) offers a possible compromise between these extremes. This paper presents the factors considered in designing a prototype of such a network-based testing system. The issues considered include:

- which type of LAN to choose for the prototype
- whether to use a test server or a file server
- whether to use a minicomputer or a microcomputer as the host for the server
- how to choose methods for entering and editing questions in the question bank
- how to determine what data to collect during the testing process
- how to report data collected during the testing process
- how to choose methods of ensuring that data collected during testing is protected from accidental loss and from inquisitive students
- how to choose methods of ensuring the security of the testing process.

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# DEVELOPING CBT FROM A STAND-UP TRAINING CURRICULUM

MARY JEAN BREWER

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Trainers and educators recognize interactive CBT as an effective alternative to the traditional lecture-style instructional method. Advances in course development software packages and cost effective hardware place CBT within the reach of almost anyone with training needs. A good curriculum can be enhanced or simply given new life when adapted (wholly or partially) to a computer-based format. There are, however, advantages and disadvantages to developing a CBT course from material intended for traditional instruction.

Oak Ridge Associated Universities (ORAU) recently completed a three year project for the U.S. Navy. During this time, an ORAU training team developed and implemented training throughout the U.S. for the Navy's new pay and personnel reporting system. Last year the Navy tasked this ame team with developing a CBT course for new and replacement field site system managers. This project was initiated with the assumptions that the ORAU team had acquired subject matter expertise and the basic curriculum was developed and well-tested.

This presentation addresses lessons learned in developing CBT from a stand-up training curriculum. Issues include preparation, selecting material appropriate for the computer-based medium (using CBT to its best advantage), working with hardware/software constraints, and course distribution.

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# ADVANTAGES AND DISADVANTAGES OF RECENT DEVELOPMENTS IN ICON-ORIENTED AUTHORING SYSTEMS

Jay R. Cook* - The University of Iowa

Timothy L. Phillips - The University of Iowa

Computer-based authoring tools have evolved from low-level programming languages to powerful authoring systems. This evolution has been driven in part by a need to provide courseware developers better access to the ever increasing capabilities of the computer while keeping the tools relatively easy to use. Icon-oriented authoring systems are the latest development. These systems let the developer plan the entire lesson in a flowchart form followed by the development of individual screens. This top-down approach is in agreement with instructional design methodologies and may provide a design environment that encourages the development of better software.

Icon-oriented systems (e.g., Course of Action and Icon Author) promise many benefits over older courseware creation methods (e.g., programming languages or authoring languages). Although these new systems do have advantages over previous authoring tools, they are not without limitations. As with most software, the greater the capabilities of the tool, the greater the level of expertise (and hence, learning time) required of the designer. Icon-oriented systems require a substantial time investment when first learning to develop lessons. (Other authoring tools have similar learning curves.) Lesson functions which are a normal part of most lessons may be considerably difficult if not impossible to implement using icon-oriented systems. In some respects, lesson development is more an exercise in programming than high-level authoring.

In this presentation, we will review the evolution of authoring tools. The authors have used an icon-oriented authoring system (Course of Action) to develop supplementary materials for a statistics course. Based on our experiences, we will address the promises and problems of these systems, offer general observations, and provide guidelines with evaluating and selecting these systems.

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# THE CASE STUDY AS A TRAINING METHOD IN CBT

Tony Devlin, Ericsson Expertise Ltd.

Susan Clancy, Ericsson Expertise Ltd.

The use of Case Studies can provide a powerful means of integrating and reinforcing learning material in a CBT context.

At Ericsson Expertise, we have employed a Structured Action Maze technique in the construction of Case Studies to revise and apply knowledge acquired through conventional CBT material.

The Case Studies are implemented in a CBT Authoring Language (TenCore) and contain substantial graphics and animation elements within a multiple-choice decision making format.

The student is presented with a simulated "real-life" scenario and is required to employ declarative and procedural knowledge gained in earlier CBT lessons to solve problems and make decisions.

Our presentation will focus on the application of the Case Study techniques to a Data Communications course entitled "Understanding Modems".

Topics addressed in the presentation will include :-

- Student routing and the structuring of the Action Maze.
- Writing the scenario and relating its contents to the CBT learning material.
- Designing appropriate feedback, guidance and remedial sequences in the Case Study.

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# APPLICATIONS OF CONCURRENCY IN COMPUTER BASED INSTRUCTION

David Dow - Microsoft Corporation

Jill Arnow - Microsoft Corporation

Multitasking operating systems provide many new and exciting opportunities in the computer based instruction (CBI) of application software. Concurrent CBI implies that the CBI and the target application are separate processes executing simultaneously on the same machine. This framework provides many distinct advantages over both traditional embedded CBI, and application simulation for CBI purposes.

Embedded CBI is a viable solution for small applications but can introduce an inordinate amount of code complexity into large-scale applications software. Simulating the application within the CBI requires that the CBI developers construct an accurate representation of the application visuals, and limits CBI interaction to well-defined instructional scripts.

Concurrent CBI provides nearly the same degree of sophistication as embedded CBI, while retaining the same degree of independence from the application as simulated CBI. Concurrent CBI presents unique challenges in design. Often, sophisticated communication links between the CBI and the application will need to be defined, mandating that the target application be "CBI-aware."

Instructionally, concurrent CBI provides capabilities that cannot be achieved in simulated environments. Forms of "coaching," ranging from simple application templates to adaptive tutorials are examples of instructional techniques that are ideally suited to a concurrent CBI environment.

In the presentation we will be addressing both the programmatic and instructional implications of creating concurrent CBI. After this session, the participants should have a good understanding of both the technical and instructional considerations that must be given to the construction of concurrent CBI.

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# THE CREATIVE USE OF GRAPHICS IN COMPUTER-BASED TECHNICAL TRAINING

Robert C. Fratini

AT&T National Product Training Center

In 1986, the AT&T National Product Training Center began development of computer-based maintenance training in support of AT&T's flagship digital central office, the 5ESS® Switch. This was the organization's first large-scale CBT development effort, as well as the first to make extensive use of animated color computer graphics.

This new (for the organization) style of CBT required very different development processes and roles, which have evolved over the past three years. Computer graphics technology has also changed considerably since this project first began.

The courseware has been received very positively by corporate customers who have licensed it. The final course of the core 5ESS Switch curriculum came on-line in January 1989. Now that we can catch our breath after three years of furious courseware development, the Electronic Training Systems staff is evaluating the processes, roles, and software tools which have brought us to this point, and determining which of these we wish to carry with us into the future.

To a large extent, the extensive use of animated computer graphics has been made possible by our creation of these graphics in the NAPLPS (North American Presentation Level Protocol Syntax) standard, a videotex protocol not widely used in the United States. The inherent capabilities of NAPLPS graphics will be a major theme throughout the presentation.

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# ISSUES IN SIMULATION DESIGN

RUSSETT GOULDING - THE UNIVERSITY OF MARYLAND UNIVERSITY COLLEGE

JAMES H. RAWSON - THE UNIVERSITY OF MARYLAND UNIVERSITY COLLEGE

This presentation discusses the use of a variation on the traditional ISD model to develop good simulations: realistic, believable learning environments. The process consists of the following four steps:

1. Perform Environment Analysis: describe the real situation within which the student must operate. This "big picture" with a description of the key elements sets the stage for a variety of learning situations.

2. Determine Critical Events: describe typical situations that the students must learn to resolve correctly. Again, describe the key elements that interact in each particular situation.

3. Determine Outcomes: for each situation, determine the possible actions the student could take and what outcomes (both positive and negative) would result. These become the feedback mechanism.

4. Determine Sequencing: some outcomes have implications for other situations within the simulations. Once these links are defined, analyze the possible paths to determine the appropriate sequencing scheme. Part of this task may involve appropriate modification of situations. For example, critical events can be simplified by the removal of distractors or a "mentor" may be added to explain concepts.

This approach helps insure that the simulation maintains believability: students immediately sense the relevance of what they are learning and subsequently transfer that learning to the real world.

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# Using Videodisc Technology with

# Teacher Observer Training

**Michael E. Hale**
**Russell H. Yeany**
**William Capie**

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## Objective

The purpose of this presentation is to outline successes and problems encountered when using videodisc technology to train groups of classroom teachers and school administrators to use a state mandated teacher assessment instrument. The discussion will address the strategies used to develop the video examples, the effects of two different group instruction strategies, and the difficulties associated with assessing performance levels using video examples. The implications of these problems to the use of videodiscs for teaching simulations will be set forth for the attendants.

## Relevance

Assessing the performance of new classroom teachers for certification is expanding in many states such as Georgia, Texas and South Carolina. These assessments require trained observers and the reliability of the assessment depend on the training received. The use of video with observer training, at first seems straight forward, but this straight forward approach becomes a twisted jungle when mixed with teacher observation assessment instruments. The presentation of the results of a prototype videodisc teacher observation training project may provide some insight for other interactive videodisc developers working with soft-knowledge training.

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# Assessing the User*

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## ABSTRACT

Computerized instruction must be created with the user in mind. All too often "someone" decides that course material should be computerized and sets about to do this glorious thing. Unfortunately, the creators of computer based training often fail to consider a user profile.

One of the most important system design decisions is finding out what the user wants and needs. Most users, or students, know what their problems are and have a good idea of what needs to be done to help solve them. It is up to the course creators to identify factors contributing to the user's problems, analyze these factors, and address the findings. User problems impact the effectiveness of an application and prevent users from working with a system in a competent manner.

Interviewing prospective users about their training experiences and expectations provides information for the creation of courses which appear to be individualized. Course designers need to collect background demographic information from representative users and those who are the most unique. This information is significant for an individual learning to use a complicated system and must be considered in designing courses.

Individuals responsible for designing and implementing computerized training must not lose sight of their reason for being.

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# INVESTIGATING BEHAVIORAL ASPECTS OF MICROENVIRONMENTS BY UTILIZING CAD SOFTWARE

THOMAS L. HOUSER - THE UNIVERSITY OF TENNESSEE, KNOXVILLE

Understanding the behavioral ramifications of an interior can allude inexperienced observers. Available literature often exacerbates this situation. Interdisciplinary spatial considerations are rarely synthesized: Microenvironment planning is portrayed as a reaction to functional and physical requirements without considering cultural factors; and the spacing behavior and territoriality of proxemics are presented in terms unrelated to specific applications. Further, three-dimensional concepts are demonstrated with two-dimensional graphics.

The challenge is to acclimate multi-disciplinary students to the influences that interiors have on the psychological and physical well-being, comfort and productivity of end-users. Although novices may easily confirm that functional space requirements are met, they find anticipating behavioral consequences more difficult.

To meet this challenge, computer-aided-design exercises were developed for courses involving business, hospitality, social science and design majors. No previous CAD or space-planning experience is required. Through programmed exercises, students explore proxemic zones relevant to hotel and corporate microenvironments. Typical floor plans are available for experiments. Participants explore these by manipulating computer-generated models of people surrounded by concentric cylinders that represent personal, social and public interaction zones. These images are selected from available menus. Overlapping zones suggest many behavioral ramifications. Advanced applications allow students, professionals and researchers to test the behavioral validity of space-planning solutions.

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# TRAINING NEW AUTHORS/COURSEWRITERS

John A. Merrill, Ph.D.

Nationwide Mutual Insurance Companies

Finding experienced CBT authors/coursewriters is often a difficult task. More frequently, CBT managers find it more practical to hire talented writers with no CBT experienced. This session will present ideas for turning that raw talent into a productive, efficient coursewriter.

The methodology for developing new coursewriters at Nationwide includes:

- Setting up communication channels
- Providing background through a variety of readings
- Hands-on, drill-for-skill exercises
- Making revisions to existing courses
- Sharpening listening and communications skills
- Participating in pilot test activities
- Attendance at company agent training schools

Underlying a planned sequence of training activities is organizational team building and continuous training on the specifics of CBT.

A coursewriter can be ready to fly "solo" in two-three months using a well structured training program started on the first day of the new job. Dr. Merrill will share his experiences as an instructional designer in training new coursewriters. This session will be of greatest benefit to CBT managers and supervisors.

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# INSTRUCTIONAL DESIGN: INTEGRATING COGNITION AND MOTIVATION

James R. Okey - The University of Georgia

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Instructional designs are plans to guide course developers in producing instruction. They should specify essential instructional events that need to occur in learning and the order in which these events should happen. A general misunderstanding about design leads many developers to falter in this important phase of development and produce instruction less effective than it could be. Even for those developers who incorporate appropriate theory in their design, there is much complexity for a developer to recall in the numerous ways that different learning outcomes can be achieved. An additional problem in course design is making the instruction appealing. Features of the course materials themselves can strongly affect the willingness of learners to study and persist until objectives are achieved.

To develop instructional designs that serve as blueprints (what events should take place and in what order), requires attention to theories that prescribe specific procedures for achieving a wide range of outcomes (verbal information, concepts, problem solving, etc.). Motivational design of instruction needs to be planned in concert with cognitive design so learners are attracted to and persist in learning objectives.

This presentation will demonstrate computer-based design tools and job aids (based on theories of Gagné, Merrill, and Keller) that help developers produce explicit and effective designs attending to both cognitive and affective dimensions of learning.

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# International Courseware - the Problems and Pitfalls

Jeff Oliver

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Most courseware is originally produced to meet the training needs of one group. However, it is increasingly common, especially in multinational companies, for courses subsequently to be used by trainees at different locations and even in foreign countries. The courseware author should be aware of twin problems of writing courseware for an international audience - cultural bias and translation to other languages.

Cultural bias is almost impossible to avoid entirely, since most authors will be unaware of that of their own nationality. Even when importing courseware written in English from the USA into Great Britain, a complete revision of an entire package was required in order to make the training acceptable to the British trainee, despite the common language. This presentation will show examples of different types of cultural bias and suggest some simple remedies.

It is dangerous to assume that translation of courseware into a foreign language is simply a matter of editing the text of each screen and re-compiling the course. A recent project which involved the translation of a course from English into French and then into Portuguese highlights some less obvious pitfalls.

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# EMPOWERING THE LEARNER: LEARNER CONTROL ISSUES IN THE DESIGN OF A CBT COURSE IN EMERGENCY PREPAREDNESS FOR THE NUCLEAR INDUSTRY

JAMES H. RAWSON - THE UNIVERSITY OF MARYLAND UNIVERSITY COLLEGE

BARBARA GRABOWSKI, Ph.D - SYRACUSE UNIVERSITY

The Emergency Preparedness Refresher Training was designed for personnel of nuclear power plants. Replacing 4-5 hours of traditional classroom training, the CBT version was designed for diverse personnel including secretaries, engineers, and vice presidents.

To best meet the needs of a population with widely varying entry-level knowledge and learning styles, we decided to design the courses around three linked modules: 1) a scenario-based diagnostic pretest; 2) a tutorial; and 3) a reference aid. Each of these offers a different degree of learner control and access to content. Upon registering for the course, the learner may choose to begin the pretest or the reference aid. The tutorial can be accessed from within the pretest. In keeping with the desire to maximize learner control, learners may leave any module at any time.

The pretest consists of emergency scenarios which require the learner to remember appropriate information. The tutorial engages the learner with questions designed to enhance meaningful understanding. The reference aid module includes interactive charts which display content in schema that aid recall.

Unique design strategies which we incorporated in these lessons include screen design components (such as color, windows, etc.), navigation aids, and structured feedback which uses wrong responses to build a study aid. To help with self-assessment, both pretest and reference aid modules provide performance objectives for all content.

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# A COMPUTER-BASED INSTRUCTIONAL DESIGN WORKSHOP FOR DEVELOPMENT TRAINING

DR. THOMAS C. REEVES - UNIVERSITY OF GEORGIA

DR. KENT L. GUSTAFSON - UNIVERSITY OF GEORGIA

IDioM © is a computer-based process, model, and set of tools for guiding and assisting in the systematic development of training. It was developed for the Training Support group at Apple Computer, Inc. It harnesses the interactive power of the Macintosh computer to provide the beginnings of a powerful instructional design workstation. IDioM operates in HyperCard to provide instructional analysis, design, development, evaluation, and management support during training development. Included in IDioM is an information base concerning the instructional development model and each of its functions, activities and tools. Specific tools for performing each of the model's activities are also included. Many of the tools call other applications such as Excel and MacWrite to access forms, guides, and templates. Other tools are interactive decision aids programmed in HyperCard. The background of the project will be described and the content and structure of IDioM demonstrated.

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# THANK YOU FOR CALLING...

Debra Schweitzer - Online Computer Systems, Inc.
Shelly Geasler - Online Computer Systems, Inc.
Maureen Lukenbill - American Express Travel Related Services

Other than bills and invoices, telephone support is often a company's only link to its clientele. It is critical that the image projected by a telephone representative be professional and helpful.

Online Computer Systems, Inc. has been involved in the design and development of a training system that simulates the on-the-job environment of American Express Membership Service Center telephone representatives. This simulation is made possible by the marriage of CD-ROM-based digital audio and traditional computer-based training. The digital audio presents typical telephone calls and the CBT evaluates and scores the trainee's interactions with a simulated mainframe system.

The essence of this approach is that "Practice Makes Perfect." By giving trainees the opportunity to practice taking typical calls, they will become proficient with the mainframe database systems with which they interact. Their familiarity with the system will allow them to close customer questions and disputes quickly, accurately, and in a relaxed and confident manner.

This presentation will describe and demonstrate the design of the American Express telephone training system.

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# THE METAMORPHOSIS OF A LEARNER-COMPUTER INTERFACE

Rod Sims - Kuring-gai CAE

Developing commercial Computer-Based Training (CBT) applications places demands on the production team to produce a viable product. Apart from content accuracy and cost-efficiency, an effective learner-computer interface is also paramount. In one such case, the learner-computer interface went through a series of stages, a metamorphosis, to reach its current state. From an initial menu-driven format with no supporting user metaphor, the interface was modified to a colour-coded content map which in turn was superceded by an icon-based map and text prompts. After further experimentation, the production interface incorporated a constant screen metaphor with sequence controls and completion status determined by icons.

This presentation provides valuable insights into the development of major courseware applications using current technologies, including the difficulties in rationalising instructional requirements with corporate demands. More importantly, the presentation considers the benefits of developing a metaphor which will increase the learner's ability to interact with the content material through non-verbal control icons designed to minimise conscious sequencing by the learner. In discussing the development of the interface and the associated courseware, the importance of instructional frameworks for the development of courseware will be emphasised.

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# USING COMPUTER-ADMINISTERED TESTS TO TEACH

Richard L. Young*
Federal Law Enforcement Training Center

Traditionally, tests are given one day and returned another. In the meantime, the students learn new material. By the time the test is graded and returned, the student is only interested in his or her score. This presentation offers an alternative and demonstrates the teaching power of the computer when used for test administration.

The application was developed as a practice test for students participating in the Inspector General Basic Training Program at the Federal Law Enforcement Training Center. Based upon the guidelines of Alessi and Trollip, it was designed to give the student the same flexibility he or she enjoys when taking a paper and pencil test. The student can move freely within the test, temporarily skip questions, and review or change answers prior to the test being scored. Unlike the traditional test, however, the student immediately receives his or her grade after completion. More importantly, while the student's interest is high, he or she has the opportunity to see the questions missed and learn why his or her answers are wrong and the other answers correct.

In contrast to paper and pencil tests, computer-administered tests such as the one demonstrated not only enable the teacher to determine how well the student knows the material, but also provide the student with an additional learning opportunity.

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# INTERACTIVE LEARNING:

# MATHEMATICAL CONCEPT DEVELOPMENT

Emile Attala, Adelaide T. Elliott*

California Polytechnic State University

This presentation discusses a project in which secondary school mathematics teachers are receiving preservice training in the art of developing interactive learning software.

Through the use of the PILOT authoring language an interactive design for the instruction of a mathematical concept is programmed by each participant in support of future teaching and learning activities.

This presentation describes a response to the U.S. Office of Technology Assessment (OTA) on the integration of new technologies in our schools.

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# DIFFERENTIATING INSTRUCTION FOR THE ACADEMICALLY GIFTED (K - 12) USING INTERACTIVE TECHNOLOGIES

JANET AZBELL, DIRECTOR

STAFF DEVELOPMENT PROJECT, WICAT SYSTEMS

Computer assisted interactive video (C.A.I.V.) is a recent addition to the media options available to instructional designers. Interfacing a computer with a video cassette recorder or videodisc player provides the flexibility and accessibility of computer assisted instruction with the impact and immediacy of video motion, color, and sound; all this, while providing the feedback and documentation generally associated with live instruction.

CD-ROM (Compact Disc - Read Only Memory) has also allowed the instructional designer new choices in the development of instruction. The storage of vast amounts of graphics, text, and digitized audio information which can be accessed by the designer as the lesson proceeds opens possibilities for lesson differentiation to meet the specific needs of academically gifted students.

Lessons in science and art using C.A.I.V. and computer assisted instruction (C.A.I.) using CD-ROM technology which have been differentiated for the academically gifted will be compared with non-differentiated lessons on the same subjects. The basis for this differentiation of instruction for the gifted will be generally agreed upon learning characteristics of the academically gifted student. Instructional differentiation will be centered on the use of language, application, type of feedback, and the amount of user control allowed the gifted learner.

The discussion will include information on the hardware requirements for classroom implementation. The relationship of C.A.I.V., C.A.I. and CD-ROM to the classroom setting will be considered. Handouts, including flowcharts of the instructional design and theoretical/empirical rationale supporting the design, will be provided to the participants.

As time allows, additional information on the development and implementation of interactive video technology in teacher education will be shared. An interesting aspect of one C.A.I.V. teacher education project is an outreach program to provide training and equipment to public school teachers who wish to develop interactive video materials for use in their classrooms. Examples of teacher-prepared materials as well as materials developed by gifted students will be discussed.

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# Establishing a Management Plan for a New Microcomputer Laboratory

Alan D. Evans - Kent State University

In this age of Future Shock (Toffler, 1970), with technological change occuring at a faster and faster rate, administrators often make decisions on the basis of heuristics--rules learned through experience. Although very useful in many management situations, heuristics may be less useful in decisions involving high technology because of the rapid rate of change. Therefore, there is a need to confirm and/or extend our heuristics through a more systematic process of applying models and collecting data.

The installation of a new computer laboratory requires administrative decisions concerning goals, physical space, budgets, curriculum, software, users, etc. A model for understanding change in organizations (Leavitt, 1978) can help with these decisions by showing how a new technology can bring about interrelated changes in goals, organizational structure, and people (staff and users). Models by Rogers (1983) address how organizations and individuals deal with change and provide generalizations which also guide administrative decisions.

Information gained from managers of computer labs provides another source of information. When this information is aligned in table form with phases and generalizations from the models, the overlap as well as the unique perspective of each approach contribute to decision making.

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# THE NATIONAL DIFFUSION NETWORK: SOURCE OF EXEMPLARY COMPUTER ASSISTED INSTRUCTIONAL PROGRAMS

Frances Hensley - The University of Georgia

Mary Ann Hindes - The University of Georgia

Educational computing is at risk. The educational community and the public at large are aggressively demanding that computer advocates produce evidence that the money spent on computer resources will not be squandered. Although drill and practice applications are useful, the future lies in implementation of word processing, problem solving software, simulations, and other software that make new and better ways of learning available to students. Computers don't teach; they deliver instruction through programs developed by computer educators who have the vision and ability to integrate existing disciplines and computer assisted instruction.

Identifying exemplary computer assisted instructional programs is often a confusing task. An appropriate source of programs is through the National Diffusion Network (NDN), a systematic delivery system administered by the U.S. Department of Education's Office of Educational Research and Improvement. Only programs which have been approved by the Program Effectiveness Panel are included in the NDN. By sharing successful products and practices among states and across the country, local educators increase their awareness of options available to meet locally identified priorities. Through the NDN, inservice training and technical assistance are available to schools which adopt these programs. In this session, several NDN projects utilizing CAI will be presented.

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# EFFECTIVELY INTEGRATING A NETWORKED MANAGED SYSTEM FOR AT-RISK STUDENTS

Dean Kephart - MECC

Paul Weiser - MECC

MECC Management Master (MMM) is a teacher-centered courseware management system. The teacher can set up a number of curricula, each with a unique scope and sequence of instruction, that meet the needs of particular groups of students. Teachers are free to assign content to lessons, and may also adjust instructional variables in the associated computer programs. While the students are progressing through the curriculum, the teacher can print a variety of reports suitable for parent reports or for diagnostic purposes. The teacher also receives notices if a student has difficulty with a lesson or if a student completes a sequence.

Two examples of the integration of MMM for at-risk populations are presented. In one model, at-risk students remain in the classroom and Chapter 1 services are provided both in the classroom and in the computer lab. MMM resides in the lab to reinforce skills and assure teacher mastery was achieved. The second model features a center containing a totally hands-on facility including a TV studio, a puppet theater, a science lab, interactive video, library, and MMM. All students attend the lab to tie this technology to their classroom instruction. MMM is focused on skill development in reading and math.

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# INQUIRY-BASED LEARNING WITH LEVEL III INTERACTIVE VIDEODISC

BRENDA C. LITCHFIELD - FLORIDA STATE UNIVERSITY

The majority of computer programs designed for classroom use fall into one of two categories: linear and drill and practice. Recent advances in technology now make possible the incorporation of videotape and videodisc into computer-based instructional materials but most of these programs also tend to be linear or they offer only simple step through access of a disc. Students are guided through these programs on a path more or less predetermined by the program itself or the teacher. The opportunities for students to actively interact with the materials or participate in decision-making strategies and inquiry learning are not built into these programs. Thus, students do not get much practice in developing higher order intellectual skills and problem solving skills.

While the verbal and math skills of students in elementary and secondary schools have improved in the past 20 years, most students cannot apply these skills to complex intellectual tasks. Technology can be used to help move students toward clearly defined goals, and is able to play a role in improving school performance. It is believed that we have not yet invested in the research and development needed to make technology useful to teachers and students.

This presentation will focus on the development of an inquiry-based, level three interactive videodisc project (nine discs) funded by The National Science Foundation and Houghton Mifflin Company and designed specifically to promote critical thinking and problem solving skills. Design issues including Hypercard development, video production, and programming will be discussed and illustrated.

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# USING HYPERCARD FOR INSTRUCTION IN LANGUAGE LEARNING

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HyperCard is designed to manage information, images, animation and sounds. It can provide the learner with a variety of learning stimuli. Research data suggest that a variety of learning stimuli may enhance both the short term and long term recall of learned materials.

Proficient language learning requires that a student be exposed to a variety of learning stimuli such as seeing the image of an object, seeing the name of that object and hearing the name of that object pronounced. It requires repetition of sights and sounds.

The French language application developed by the presenters uses the capabilities of HyperCard to provide this repetition of sights and sounds. By passing a Macintosh mouse over the image of an object, a student sees the written name of the object in French and hears its French pronunciation. The student can repeat this procedure indefinitely. A French-English dictionary is always available to the student during the lesson.

The presenters will discuss the process of the creation of this HyperCard application, demonstrate the application and suggest other language applications that could be developed using HyperCard.

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# Merging Interactive Video, Electronic Note Capturing, and Word Processing

Kyle Peck & Robert Wambaugh

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Demonstrates an interactive video lesson based on the Texas Learning Technology Group's Physical Sciences Series. This lesson on Ohm's Law allows the student to capture text presented on the computer screen to a note file, into which the student may also type original notes. Students may also pause video segments, view the script of the video, and capture notes from the script. They may leave the lesson and enter a full-featured word processor and return to the lesson at the point of departure.

This combination of interactive video and electronic text processing allows students to gather information: 1) for subsequent study; 2) to use in the preparation of papers; 3) for entry into a personal "contents addressable" database for use when the interactive video lesson is over and video equipment is no longer available. The model seems especially promising in professional training environments.

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# ELECTRONIC PEN PALS: SECONDARY EDUCATION MAJORS AND JUNIOR HIGH STUDENTS

DR. CHARLOTTE SCHERER

BOWLING GREEN STATE UNIVERSITY

Secondary Education Majors learned about telecommunications, and gained insights about junior high students through an electronic pen pals project. Volunteer secondary education majors were matched with junior high students in Computer Literacy classes. The pen pals communicated on-line using the electronic mail portion of a local bulletin board service.

Thirteen secondary education majors, and 70 junior high students participated after learning to use telecommunications. Each college student wrote to 5 or 6 junior highers. Project culmination was a face to face session. This earlier project was revised and implemented again in the Spring of 1989.

Project goals include:
1) to provide education majors with:
    a) insights about junior high students;
    b) experience using telecommunications; and
    c) opportunitites to see "real world" computer use;
2) to provide junior high students with:
    a) an opportunity to use telecommunications;
    b) an adult person with whom they can share their ideas, interests, and problems; and
    c) information about computer use in the "real world";
3) recruitment of students for secondary education microteaching

Evaluation indicates goals were met, insights were gained by both sets of students and problems of initial implementation were overcome, as indicated by results of the Spring, 1989 version of the project.

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# The Development of an Interactive Videodisc Simulation of a Frog Dissection

Richard Strauss - University of Virginia

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## ABSTRACT

The Frog Dissection simulation is an interactive videodisc designed for high school biology students. Using a combination of vivid close-up photography and explicit narration, it demonstrates the proper procedures for dissecting a frog and locating its major organs.

The dissection of animals in the science classroom continues to become more controversial. Students are refusing to participate in this type of lab procedure for ethical reasons, despite its instructional value. Suitable alternative activities are needed.

Smith and Lehman (1988) proposed that research findings indicate a potential usefulness for interactive video in the teaching of science laboratory techniques. It is anticipated that this IVD application will promote improved learning of dissection procedures and frog anatomy. The program is also expected to promote greater motivation for science students and more positive attitudes toward science.

This presentation will allow the developers to share a description of the design, development procedures, and research plan for this level 3 interactive videodisc. Session participants will learn how Hypercard was used to facilitate the design of the videodisc. They will also see a demonstration of the interactive Frog Dissection lesson using the IBM Infowindow System. An evaluation of the materials and design procedures will be included.

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# Basic College Writers at the Computer

Gary Vaughn

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The 1988-89 academic year marked the third year of an ongoing study at the University College of the University of Cincinnati to measure the effects of classroom computer use on the composing processes of develomental writing students. The study originally involved the same five (now six) English instructors and a varying number of sections of a developmental writing course with a combined yearly enrollment of approximately 200 students. The students are placed into this course on the basis of their performance on a holistically-graded essay and on the Development of Reading Powers Test, and they have the opportunity to retake the test at the end of each quarter, with a passing grade being required for entrance into the Freshman English sequence. Classes involved in the study used either the Bank Street Writer II word processing program, or Bank Street Writer II in combination with William Wresch's Writer's Helper writing-aid program, or had no computer usage at all. All classes in the study used the same syllabus with the same assignments and the same point-based grading system. Each instructor taught both experimental and control groups. Results from the past three years show no appreciable differences among the three groups in terms of quarter grade and the percentage of students passing the essay test. However, when the results are viewed in terms of older, non-traditional students compared with traditional students just out of high school, a much higher percentage of the non-traditional students passed the essay exam if they were in classes that used Writer's Helper. We speculate that these results might indicate the computer's ability to appeal to the characteristics of adult learners identified by Malcolm Knowles, Stephen Brookfield, and Paul Westmeyer. Student evaluations reflected a good degree of satisfaction with using computers, and also showed that students in the computer classes were more likely to find assignments "interesting and stimulating." This presentation will explain the methods used in the study and will explore the findings as they relate to research on the adult learner.

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# SCIENCE INSTRUCTION ON GLOBAL ELECTRONIC NETWORKS

MICHAEL L. WAUGH* - DEPARTMENT OF CURRICULUM AND INSTRUCTION

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Real world science is conducted in global contexts, with collaboration among colleagues around the world a common occurrence. With the spread of microcomputers into science classrooms and the availability of electronic networks, it is now possible to conduct science instruction in such global contexts as well. This presentation will discuss ongoing research into the ways in which electronic networks can be used in science teaching and learning. These networks allow students to participate in distributed science problem solving activities by providing dynamic support so that students can gather and analyze data and jointly create project reports with students from other parts of the world. Several of these "telescience" activities will be described in detail. In one activity, students from across the United States have been engaged in data collection and data analysis activities related to estimating the circumference of the earth. In another activity, students and teachers participated in the collection and analysis of data concerning the availability and expense of selected food items around the world. The session will conclude with a discussion of the potential of these networks for improving science teaching and learning.

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# Implications of the Emerging Technologies for the Role of the CBI Designer:

## The Situation at The Ohio State University

Salvatore M. Abate

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Computer-based instruction has been used at The Ohio State University since 1968. The Computer-Based Instruction group, in its various administrative forms, provides faculty with consultation on the design, development, and delivery of courseware. The role of the group's professional staff has changed in response to developments in CBI technology, instructional design theory, and administrative support.

For fifteen years mainframe-based systems were the only CBI development and delivery tools available at OSU. The Ohio State University now has a large installed base of PCs and Macintoshes, a growing wide-area network with a fiber-optic backbone, and classrooms augmented by multimedia technology. Faculty interest in the use of videodisc, CD-ROM, and hypermedia is high. The staff of the CBI group has had to re-define and expand its activities to better meet the challenge presented by these developments.

Although the mainframe system still provides over 80,000 hours of interactive instruction each year, its use will be phased out during next two years. Funds now spent on mainframe courseware will be used to support the conversion of these programs to microcomputer versions, the development of new courseware, and the installation of local-area networks for course delivery.

This presentation will review the past and current state of CBI activity at OSU, how the roles of the CBI design staff have been affected by the introduction and evolution of new interactive technologies, and how we plan to accomplish the migration from a highly centralized mainframe-based system to highly decentralized microcomputer-based systems.

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# Evaluation of Authoring Systems for Hypermedia-Based Instruction

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Craig Locatis, Michael Weisberg, and Victor Carr
Interactive Technology Branch, National Library of Medicine

While a hypermedia approach to interactive program design holds promise for instruction and for information exchange, commonly used authoring tools are often limited in terms of features that are both required and desirable for hypermedia systems. In order to identify an authoring system capable of producing sophisticated and flexible hypermedia-based interactive programs, a method of authoring system evaluation based on a detailed checklist was developed.

Through the use of the authoring system evaluation checklist, individuals can evaluate potential authoring systems in six major categories: hardware, lesson features, user interface, answer analysis, management features, and price. Individual characteristics are examined within this framework, such as: use of varied source materials (computer, videodisc, CD-ROM, digital audio), multiple input capability (simultaneously functioning touch screen and keyboard, for example), ability to access external programs, and the interactive branching associated with hypermedia.

Use of this authoring system evaluation method can help identify the most likely candidates for a particular project, saving time in the evaluation process and allowing for a closer examination of only the most suitable programs. Use of the evaluation method will be demonstrated, and strengths and weaknesses discussed.

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# The Computer Technology Resource Center's Special Education Technology Program

Stephen W. Harmon - The University of Georgia

John Langone - The University of Georgia

The Computer Technology Resource Center for Handicapped Individuals (CTRC) was established in the Spring of 1988 to improve the lives of handicapped individuals through the use of new microcomputer and computer assisted technologies. The center seeks to accomplish this goal in three ways: by establishing and maintaining a network of special education technology users, developers and resource people, by acting as an information clearinghouse, and by increasing the quantity and improving the quality of special education technologists in the state of Georgia. The CTRC has recently received federal funding to assist in its efforts toward these ends.

This presentation examines the structure and workings of the CTRC, explores its innovative networking and implementation system, reports on the creation and implementation of a special education technology area of study in The University of Georgia's Division for the Education of Exceptional Children, and suggests ways that similar programs might be set up elsewhere.

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# AI and An Intelligent Tutoring System

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Research in artificial intelligence has given rise to a new teaching tool: Intelligent Tutoring Systems. These systems incorporate knowledge about the student, the subject domain, and the instructional strategies required by particular content areas. This paper describes an intelligent conversational tutoring system that uses AI techniques for knowledge representation and reasoning. The uniqueness of this system is that it is capable of dynamically modifying its teaching rules based on a past performance data and the current state of discourse.

The system models the student's understanding and controls the conversation after analyzing student knowledge data. At each step, the inference engine is capable of doing fine grain reasoning and can make decisions on the next course of action. The system consists of a parser, input analyser, and an inference engine. A student model, a database of teaching rules, and subject matter are maintained independently and can be readily updated with a word processor.

This intelligent tutoring system is more advanced than conventional expert systems, which direct the learner's discourse by using fixed decision rules. The system also provides help and is capable of tailoring problems to the appropriate learner level. The system can be extended to implement a complete course by using a planner to coordinate various components of the course.

# HYPERMEDIA:

# A TOOL TO HELP LEARNERS AVOID MISCONCEPTIONS?

DIANE MCGRATH*

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Learning in complex, ill-structured domains is often riddled with misconceptions which persist despite instructional attempts to overcome them (e.g., Spiro et al., 1987). Hypertext-controlled interactive video may provide a useful medium for presenting the learner with the possibility of traversing the material from a number of different directions and in several contexts, a condition which has been shown to aid in transfer (Spiro et al., 1987).

The findings to be presented will be based on a study of acquisition, retention, and transfer by college-age learners under 3 conditions, presented as (1) straightforward videodisc playback; (2) a hypertext document with videodisc access; and (3) traditional menu-driven CAI controlling access to videodisc material. Only the type of control of the videodisc will vary.

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# LouLou: Anatomy of an Expert Tutor

**John Milbury-Steen**
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Presents the anatomy of LouLou, an expert tutor who coaches students in drawing pictures of simple molecules. The presentation presupposes no knowledge of chemistry.

After a gentle introduction to the subject area, LouLou's vital organs are probed. The basic database about the molecule captures its current state. The historical database summarizes what aspects of the molecule have improved or deteriorated. The student model keeps a record of the student's proficiency for each skill. The tutorial rulebase of "act messages," represented as a graph, identifies the nature of the last change made to the molecule, and generates advice, criticism, and praise. A second tutorial rulebase, the "state messages," comments on long-standing errors in the molecule. These comments may be suppressed if the student asks for a low level of intervention, for the verbosity of the tutor is partially under student control.

The presentation then discusses how the conflicting agendas of these components are resolved. The act messages may suppress the state messages. The level of intervention set by the student may be adjusted by the student model. The student model, in order to set accurate readings for skill proficiencies, may temporarily suppress comments from LouLou altogether.

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# Re-examining the Purpose of Publication: Using Hypertext and Computer Tools to Serve the Reader

Kyle Peck

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An analysis of why readers read professional literature and their uses for the information leads to this proposal for more powerful alternatives to traditional distribution channels and formats. The presentation demonstrates an "article" designed to meet the needs of the readers as well as the author. To ensure that the author's perspective is conveyed coherently, the initial reading of this article resembles the traditional, paper-based form. However, after initial reading, several new options allow readers to make more effective use of the author's work, during both research and writing stages.

The author's thoughts are supplemented by two levels of reference material: 1) direct quotations from other authors, tied (via mouse-activated buttons on the screen) to points made in the article; and 2) detailed reference notes on each publication cited, extending beyond the immediate topic of the article. A fourth level of information is created as readers attach comments to the author's thoughts for subsequent readers to view.

Electronic "note capturing" is available at all four levels, so readers may collect thoughts to support writing activity for entry into a personal database. "Seamless" access to the preferred word processor is provided so the reading and writing processes need not be separate stages.

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# Instructional Solutions Using HyperCard

Lawrence C. Ragan* - Penn State University

Barbara Polka* - Penn State University

This session will focus on the use of Apple's HyperCard software program as a courseware development tool at the Computer Based Education Lab at Penn State. Criteria for the evaluation of authoring systems or languages used by CBEL will be discussed. The application of these criteria to HyperCard as a courseware development program will be presented. Instructional design considerations and the capabilities and limitations of HyperCard will also be discussed. Courseware developed using HyperCard will be demonstrated including The Weed Identification and Key System, The Evolution of the Spanish Language, The Political Process Exercise, Diagnosing Reading Abilities: Case Study Simulations, and The Superior Egg.

The broad outline for the session will include the following topics.

- Criteria For Authoring Tools
- HyperCard Defined
- How Does HyperCard Stack-Up?
- Penn State's Instructional Solutions Using HyperCard
- Available HyperCard Resources

A brief overview of the Computer Based Education Lab at Penn State will also be presented including: definition of project development teams, faculty support structure and methods and concerns of software distribution.

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# An Assessment of the Effects of Induced and Natural Student Self-Perceptions of Creativity on Student Performance in HyperMedia Environments.

Thomas C. Reeves - The University of Georgia

Stephen W. Harmon - The University of Georgia

The phrase "I can't do it; I'm not creative" is heard all too often in classrooms today. Students' are frequently labeled as being either creative or not creative by their teachers and peers early in their educational careers. Regrettably, in many cases these labels stick for life. Research tends to support the "Pygmalion effect" for creativity in education.

As more emphasis is placed on individualized instruction in discovery environments, student's self-perceptions of creativity become more important. The degree of control a student has in a computer-based instructional system should be heavily dependent on the student's ability to develop or use sound meta-cognitive strategies in her or his exploration of that system. Whether students take full advantage of discovery-type learning environments may be closely tied to their creativity or self-perceptions of creativity.

This presentation will report a study conducted by the presenters that examines what effects students' creativity and perceptions of their own creativity have on their use of discovery-type, hypermedia environments. Further, it will suggest strategies for, and show hypermedia examples of, including affective, creativity supportive measures in hypermedia discovery-type environments in particular, and in computer-based education programs in general.

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# THE SEARCH FOR METAPHORS:

# A CASE STUDY OF A COURSE IN HYPERMEDIA

HENRIETTA NICKELS SHIRK* - NORTHEASTERN UNIVERSITY

This presentation covers some of the philosophical assumptions underlying hypertext (or hypermedia) applications as they relate to using these new technologies for the creation and management of information. It focuses on the needs of instructors to develop new approaches to teaching the writing process and new mental models for organizing information. One of these requirements is an understanding of the cognitive aspects of screen design and the chunking of information. Another related requirement is an understanding of the effectiveness of metaphors in presenting hypermedia information and a knowledge of practical skills for developing meaningful metaphors within the context of "hyper" systems.

Writers of hypermedia must abandon most of their previously held assumptions about the qualities of effective communication and learn several new skills. This presentation uses the example of a graduate-level course in technical and professional writing at Northeastern University in which students learned Apple Computer's hypertext product, "HyperCard," as a tool for creating computer-based training (CBT). Finally, as the result of this research and experience within a composition classroom, it suggests the foundations for a theory of "HyperRhetoric," which will be useful for others currently writing or planning to write within the genre of this emerging technology.

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# A ROBOTICALLY-AIDED EDUCATION ENVIRONMENT
# FOR THE SEVERELY PHYSICALLY DISABLED STUDENT

DR. PATTI R. SIZEMORE - BATTELLE

DR. RICHARD HOWELL - THE OHIO STATE UNIVERSITY

The recent development and use of robotic devices as aids in the lives of severely physically disabled individuals provide opportunity for these persons to more satisfactorily participate in life experiences. The Ohio State University Educational Robotics Laboratory was established to systematically investigate the use of robotic devices by disabled students in an educational setting. The work has grown from the implementation of a programmable mobile robot in a school setting to the development of a functional prototype robotic arm that has been successfully used in a variety of science educational activities.

Research designed and directed by Battelle has focused on: 1) training methodology, 2) the impact on the cognitive, psycho-motor and affective development of the participating students, and 3) factors that would influence successful implementation and use. Methods of data collection have included field observations, interviews, and repeated measures of visual/spatial skills, motor control, and cognitive mapping.

The variety and integration of the data provide a rich picture of a robotically aided environment. Research results include the: 1) interaction between automaticity of tasks and the transparency of the technology, 2) interaction between technological transparency and teacher/trainer role, and 3) cognitive, psycho-motor and affective impact.

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# SIMUCAT: A Program to Simulate Adaptive and Conventional Tests

Jon S. Twing*

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**The University of Iowa**

One of the most significant recent advances in educational measurement is the development of computerized adaptive tests. The major benefit of adaptive testing procedures is that scores comparable in reliability and validity to those from conventional tests can be derived using far fewer items. This benefit has led to the development of microcomputer packages, such as MICROCAT, that enable users to construct their own adaptive tests.

However, these packages do not include a mechanism for assessing the efficiency, reliability and validity of the adaptive tests they are designed to create. Without this information, it is impossible to determine whether a given adaptive test is an improvement over its conventional counterpart.

In this presentation, we will describe a computer program, SIMUCAT, that we developed for the purpose of comparing the efficiency, reliability and validity of conventional and computerized adaptive tests using items from the same pool. We will demonstrate the use of SIMUCAT to evaluate tests constructed by individual users and existing microcomputer packages.

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# THE DEVELOPMENT AND DESIGN OF A VIDEODISC SIMULATION FOR TEACHING GROCERY SHOPPING SKILLS TO STUDENTS WITH MODERATE OR SEVERE HANDICAPS

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Most authorities agree that instructional objectives for students with severe handicaps should focus on preparing them to perform functional skills in a wide variety of community settings (Brown et al., 1983). Strict reliance on classroom training alone, however, does not facilitate generalization of skills to those community environments (Bates, Renzaglia, & Wehman, 1981). Conducting training in the community while educationally desirable presents many practical problems as well. The introduction of new technologies such as the microcomputer and videodisc offer possibilities for increasing the effectiveness of these special education training programs with the creation of simulations which can model the experience of the natural environment.

This presentation will discuss the development of an interactive videodisc grocery shopping simulation. Grocery shopping was chosen as the target skill for the videodisc because of its importance as a community skill. The videodisc includes actual footage of three convenience stores. Students are able to view grocery store aisles, to see icons reminding them of the item to purchase, and to choose the item as they view the aisle.

The program was designed to be used by the teacher as a training tool with options to define individual treatment packages depending on the student's physical and cognitive capabilities. Results of its use with students with moderate and severe handicaps will be presented. Initial use focused on the student reactions to the IBM Infowindow, student recognition of video images and icons, teacher reactions to program use and to teaching grocery shopping via videodisc simulation, and teacher development of individual treatment packages. The presentation will conclude with a discussion of the implications for future research projects using this simulation and for the production of videodiscs to simulate and teach community skills for persons with moderate or severe handicaps.

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# IMAGINATIVE USE OF HYPERCARD WITH
# BACCALAUREATE DEGREE STUDENTS

MARGARET FARROW - SOUTH AUSTRALIAN

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At the School of Occupational Therapy the educational value of constructing personal knowledge-models using Hypercard's multi-linking facility is under investigation. "Knowledge-model construction" implies that the student sets up an instructional model of the concepts, principles and facts about a particular topic in such a manner as to illustrate their thinking about that information.

Each student taking the Neurology subject learns about an assigned topic through the process of researching that topic to a level where the material is known well enough to "teach" fellow students. This commonly used educational technique has, in the past, used a tutorial presentation for peer teaching. Hypercard is now the educational medium. Students are first taught how to create screens of information using graphics and text. They are then taught how to create "live" areas and to use Hypercard's multi-linking facility to demonstrate the relationships between sets of information. This construction of a personal knowledge-model which represents understanding of the links between sets of visual and verbal information about the topic is one part of the learning process. The student is required to refine the model to become a Computer-based lesson on that topic for fellow students. The second part of the process is learning about other Neurology topics through using other students' knowledge-models.

Students experiences of learning both through constructing personal knowledge-models and through using fellow students' Hypercard lessons to learn Neurology topics are under evaluation. Some attempt is also being made to measure the quality of learning.

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# SIMULATION OF GROSS ANATOMY LAB - LOWER LIMB

Julia F. Guy - The Ohio State University

Anthony J. Frisby - The Ohio State University

Interactive computer programs to simulate gross anatomy labs can prepare students for the lab experience and alleviate some of the time consuming and labor intensive problems of teaching human anatomy to large groups of students. Because anatomy is a discipline which relies so heavily on visual information, each student can spend as much time as necessary interacting with this program until he/she is prepared to recognize the structures on the three dimensional cadaver in the lab. For undergraduate students in situations where cadavers are not available, this method could provide an understanding of the body without the laboratory experience.

Overlays included in the interactive computer program help integrate it with illustrations and text in a companion lab workbook. The student will, therefore, have an opportunity to become familiar with the lesson and to have a hard copy of additional information if desired. The videodisc will allow the student to compare the illustrations with photographs of human cadavers and with motion sequences of cadaver demonstrations showing the relationships of the anatomical structures. A post-test will determine when the student has sufficient knowledge of the area to participate in the lab.

# AN INTERACTIVE VIDEO PROGRAM ABOUT TEENAGE CHILDREN OF ALCOHOLIC FAMILIES

Barbara Signer - St. John's University

This presentation will demonstrate and explain the production and features of an interactive videodisc project designed to provide information about teenagers living in families with an alcoholic parent. This program, Living in an Alcoholic Family, provides information about alcoholic behaviors, effects upon the family, the role of the non-alcoholic parent and coping/healing strategies. Teenagers use the program individually to learn about the problems that confront teenagers living with an alcoholic parent.

A teenager serves as the narrator. She introduces herself as a child of an alcoholic and explains that the user will be viewing scenes of her friends. They too live in homes where a parent is an alcoholic. The narrator introduces the scenes and provides continuity for the program. At the conclusion of the program, questions that apply to a new video scene are posed.

This program extends the use of interactive video in education, beyond the cognitive domain. In addition to providing information, it is a means of support for teenagers. It shows teenagers that they are not alone and that there are people who can help. This is a topic that requires private exploration of feelings and information. Interactive video provides this capability. Teenagers explore sensitive topics alone, while the computer tracks the areas that the teenagers choose to explore.

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# The NERB Encyclopedia of Dentistry: Project Update

John M. Straub, Ph.D. - Howard University Hospital

This presentation describes the project status of The Encyclopedia of Dentistry, an interactive videodisc-based program being produced by the Northeast Regional Board of Dental Examiners (NERB). The Nerb Board produces and administers the dental licensure examinations required by 15 northeastern states.

The Encyclopedia of Dentistry is a two year project to create an interactive reference work for use by dental students, dental instructors, licensure candidates, and practicing dentists. While the primary objective is to assist licensure candidates to prepare for the NERB examinations, the work is also intended to stimulate the use and development of interactive curricular materials in schools of dentistry. A third objective is to provide a heavily illustrated reference tool for dental practitioners.

The Encyclopedia of Dentistry will consist of a broad range of information in the fields of dentistry and dental hygiene. The textual information is being developed by ten dental scholars, each writing in a specific dental discipline. Each of the disciplines will be supported by a prodigious quantity of still images, graphics, and motion sequences contained on a 12" videodisc. The disciplines covered will be Oral Diagnosis, Prosthodontics, Clinical Oral Pathology, Dental Hygiene, Occlusion, Endodontics, Periodontics, Restorative, Pediatric Dentistry, and Oral Surgery/Anesthesia.

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# TEACHING FAMILY FUTURES PLANNING

# USING A COMPUTER SIMULATION

DEBRA L. BERKE - UNIVERSITY OF DELAWARE

BARBARA H. SETTLES*- UNIVERSITY OF DELAWARE

The Interactive Planning for Family Futures Project has designed an interactive computer program to teach family futures planning. The program - a simulation of a relocation scenario- is designed to explore long and short range planning and decision making under time constraints. Participants work through a relocation scenario exploring three domains - family, community, and work. Within each domain are topics and resources specific to that domain. Feedback is given to participants about their choices.

Throughout the program the computer tracks the player's choices; time spent in each domain; and actual time left before the decision has to be made.

At the end of the time limit (or anywhere in the program) the player can make the decision to stay or to go. After selecting one of the two options, the user is shown a hypothetical future based on their choices.

There is no right or wrong outcome to this game (to stay or to go). The negative feedback is not based on making the right choice but making the choice using the appropriate skills. The important principle of this game is that the user has developed the decision making process under the limits of time constraint by gathering information, assessing it, identifying actions and costs, and making a decision with as much knowledge as possible.

The principles of this simulation can be applied to any decision making situation involving long and short range planning, including career planning for example.

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# STUDENT TEACHING EXPERIENTIAL PARTNERS NETWORK:

# EFFECTS OF PARTICIPATION ON HOME ECONOMICS STUDENT TEACHERS

VELMA M. BUTLER

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During the fall of 1988, the Student Teaching Experiential Partners Network was set up to provide a communication link between supervisors at Oklahoma State University, a network coordinator, and eight student teachers in the field. The discrepancy evaluation model (DEM) was used to evaluate the effectiveness of the network as determined by the goals of the network. A three-group quasi-experimental design was used to determine the effect of participation in the network on student teacher attitudes and professional development. The variables measured were dogmatism, attitude toward education as a career, faith in people, self-esteem, and attitude toward education.

The network was set up utilizing existing equipment and adding modems and software as required. All participants used the system for sending and receiving messages. Seven participated in group conferences. Three participants sent documents using the system. Participants who used computers located in their homes called more often and used the network more comprehensively then those using computers located in schools. No significant difference was found in dogmatism, attitude toward education as a career, faith in people, self-esteem, and attitude toward education between the participants and non-participants in the STEP Network. Student teaching and participation in the STEP Network had no negative effect on attitudes or professional development. Student teaching was a positive experience for both the treatment and control groups.

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# The Computer: A New Approach To An Old Problem

Linda M. Heaton, University of Kentucky

Nadine Hackler, University of Florida

Is the computer a better tool than books or word-of-mouth to answer questions on care and maintenance of clothing? Is the computer a viable tool to use for this task in county Extension offices?

A storage/retrieval computer program was developed which categorizes clothing care and maintenance into ten major topics: fibers and fabrics, laundry, laundry problems, stains, drycleaning, drycleaning problems, storage, other care problems, repair and recycle. Titles within each topic can be individually accessed, or they can be reviewed progressively as chapters in a book.

Given the title CLOCARE, the program was specifically designed to assist professional and nonprofessional county Extension personnel with routine, day-to-day clientele questions and requests for information. It is not, however, limited to this environment or these individuals. Eighteen professionals and subject matter experts from business, industry, research and teaching served as content reviewers.

Approximately 25 counties and several computer professionals in two states have been involved in the pilot testing of the program. Results of the pilot and the program's use in an Extension environment will be the focus of the presentation.

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# CONCEPTS USED TO INTRODUCE STUDENTS TO SPREADSHEET

LOIS HUGHES*- MANKATO STATE UNIVERSITY

Information was shared regarding procedure and principles used to teach spreadsheet. The first examples presented introduced the concepts designed into the spreadsheet and built a hypothetical budget for an imaginary "business." After the students had built the multi-year budget including formulas for goal-setting in regard to income and expenses, the student tries some "what if" situations, and observes the results in the template.

Students are then presented with a hypothetical family budget with the requirement of reconstructing the budget and printing it. The process teaches the manipulation of the program as well as exposing the student to the construction of the sheet.

Assignments used to followthrough on the laboratory experience of constructing the family budget were shared with the group. Methods were verified through used with traditional college populations as well as non-credit adult class populations. Questions from the audience were received regarding the methods, including hardware and software used.

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# USE OF INTERACTIVE COMMUNICATION SYSTEM IN THE SUPERVISION OF STUDENT TEACHERS

Mildred Johnson & Barbara Clawson

University of North Carolina at Greensboro

The overall purpose of the project is to improve the quality of the student teaching experience through reflective feedback sessions and rigorous analysis of teaching. It was believed that an integrated communication system that combined video, audio, and data communications between the university and the high school classroom could provide a stronger linkage between student teachers, cooperating teachers, and teacher educators.

The objectives for the three year project were to: (a) identify an integrated communication system, (b) conduct a pilot study, (c) implement the system, and (d) evaluate the effectiveness of the system for use in supervision.

The communication system selected was the MINX, a two-way interactive audio, video, data full motion system by Datapoint. Cablevision channels were used as the linkage medium. The test of the system with the potential cooperating teacher in the pilot project was successful in terms of technical aspects. In addition classes were taped at the University, played back to the teacher over the MINX, and conferences were conducted to simulate the process to be used with the student teacher. Interviews with students and the teacher were conducted to determine reactions to the pilot study. The system will be implemented with a student teacher Fall 1989.

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# IMPROVING WRITING SKILLS WITH COMPUTERS

ANN B. KAPP

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Many college students have difficulty with writing papers required in classes. Grammer, spelling, style and word usage are often problems for them. In a senior seminar class, abstracts of articles were required weekly. A study was done to determine if computer software could be used to improve students' writing skills.

A computer program was used to analyze student abstracts. The analyses included readability, strength, descriptive, and jargon indexes as well as sentence structure analysis and a word list. Students were required to use the analyses and to rewrite the abstracts deciding about whether to use the suggestions made by the program. Documentation for the program emphasizes the necessity of the author making the final determinations of use of recommendations.

A rating scale was developed for use in scoring both the original and rewritten abstracts. Three English teachers served as experts for scoring the coded abstracts. Mean scores for each paper were calculated. The t-test was used on the pre and post test scores. Results of the analysis and techniques for determining if writing was improved through use of the program will be discussed. Possibilities for incorporating other specialized application software for improvement of student performance will be included in the discussion.

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440

# CUSTOMIZING CAD SOFTWARE AND CREATING A TUTORIAL FOR MERCHANDISING THE RETAIL SALES FLOOR

PHYLLIS BELL MILLER - THE UNIVERSITY OF TENNESSEE, KNOXVILLE

NINA DILBECK - CALIFORNIA STATE UNIVERSITY, FRESNO

As competition among retailers stiffens, store layout and merchandising are becoming increasingly important as means of enticing customers. However, students often do not experience this process until they enter the work force. While traditional merchandising courses require students to draw simple layouts by hand, computers allow students to experience the design and layout process dynamically.

To enliven the merchandising process, a tutorial was developed for use with AutoCAD software. As well as a student work disk that holds a variety of files, the package includes custom menus with floor plans, fixtures, macros for performing specialized tasks, and other items.

The tutorial is designed for advanced computer users as well as novices. This enables more educators to provide students with CAD skills without being proficient in the use of the software themselves. All necessary information is included in the package, permitting minimal start-up and training time. Students learn the basics of floor merchandising and progress to layouts for several kinds of stores, sales, and promotional events. Accommodating wheelchair users and others with special needs is stressed. In addition, students learn to transfer information from their floor plans to a database program in order to perform calculations and create reports.

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## FROM RAGS TO RICHES

## CRITERIA FOR SELECTING CBE SYSTEMS

DR. EMILE ATTALA - CAL POLY, SAN LUIS OBISPO

GUS W. THOMASSON - CAL POLY, SAN LUIS OBISPO

To address hardware in the rapidly evolving computer world is to write a dated article. What factors determine the required hardware for a given job and a cost effective computer lab?

Compatibility, speed and cost of a system determine the necessary hardware. Several system configurations are possible. A poor man's system would include an Intel 8086 or 8088 chip, 256k RAM, monochrome monitor and a 360k floppy drive. These slow systems handle text nicely but are without graphics capability. These systems may be upgraded with CGA color, increased RAM and another floppy drive. Color may be further upgraded to the EGA level. Data management may be simplified by adding a hard disk. Each upgrade whether it is in RAM, color, or disk storage increases cost.

The Intel 80286 chip speeds up the computer with a more powerful instruction set and a 16 bit bus. This speed is important for graphics displays. This multiprocessing environment may consist of higher resolution monitors, large aboveboard memory and large disk storage. Again, the increased capabilities result in greater cost.

Networking may lower costs by having one smart, fast fileserver, usually an 80386, with large storage capacity controlling several slower workstations. Networked software considerably reduces the individual software needed for the lab.

Video requires an analog monitor. Some VGA monitors are analog, and when used in conjunction with video eliminate the need for a second monitor.

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# Managing ICAI Development Is Not Easy

Roland Garton
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John Milbury-Steen and Joseph Brady

A project to develop an intelligent tutoring system for a chemistry topic has provided several insights regarding project management. For example, continual prototyping and revision of both the program and the development approach is a key to success. This requires a rich and responsive development environment. We used several tools--IBM microcomputers, Sun workstations, versions of C, versions of Prolog, locally developed subroutines, and so forth. The project migrated steadily towards more flexible environments with bigger machines and interpreted languages.

Team members still debate the most effective order of events for ICAI development. Case in point: Should a project develop the user interface before an extensive analysis of the task? This approach can provide a valuable tool for data collection, but at the risk of throwing away work due to a lack of sufficient theoretical underpinnings. Other challenges included staff turnover and the learning curve, which took time from development. Time was required as well to find the middle ground among staff between _a priori_ decision-making versus a more empirical approach to model building.

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# VISUALIZING THE END PRODUCT

## OR, HOW TO GET WHAT YOU PAY FOR

JANIS MORARIU, Ph.D - THE UNIVERSITY OF MARYLAND UNIVERSITY COLLEGE

MARCIA WHITNEY, Ph.D. - THE UNIVERSITY OF MARYLAND UNIVERSITY COLLEGE

The fable of the six blind men trying to describe an elephant from their six different perspectives is reminiscent of many instructional design teams. Working toward the development of a single instructional product, each team member has a unique perspective related to their specific function on the project, whether it is project management, content expertise, instructional design, programming, graphic arts, etc. The topic of this session is the exploration of visualization techniques to help project team members establish a common vision of a project goal. If all members of the team, including the client, can visualize the same final product through all stages of the instructional systems design process from the initial needs analysis through the design, development, production, evaluation, and implementation, there should be reduced miscommunication and no surprises along the way. The session presenters will discuss guided imagery techniques, creative visualization, and the analysis of self-talk as methods of achieving a common vision.

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# NAVIGATION THROUGH THE HIGH SEAS WITH PILOT AND PROPI

MEDHAT ATALLAH

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The International Maritime Organization created a document that contains certain maritime provisions that Canada, like most other nations, follows in its territorial sea and all of its internal waters. Schedule # 1 of this document deals with the international regulations for preventing collision at sea and is taught as a course in the Marine Institute at Rimouski, Quebec. Schedule # 1 is divided into eight distinct parts that basically cover all rules that govern the manoeuvering of ships at sea to prevent collision. The first three parts that are labeled "The Interpretations; The Generalities; and The Steering & Sailing" were chosen to be transformed into a CBE mode of presentation. In the interpretations part there are thirty definitions of technical terms and six applications for which the regulations of schedule # 1 apply. The Generalities include three rules that apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels. The Steering & Sailing part contains sixteen rules that deal with the conduct of vessels in any condition of visibility, actions to avoid collision, traffic separation schemes and all details that concern the safety of vessels at large.

The three parts of schedule # 1, that are included in this CBE project, contain all together nineteen rules with about one hundred articles and fifty subdivisions. These rules and their subsets lended themselves nicely to computerization because they had a tree-like structure.

Several professors at the Institute had the mastery of the subject matter, the challenge was to pick up an educational approach to turn a rather dry subject that required a lot of memorization to a fun subject that relies heavily on graphic simulation to demonstrate rules without which navigation at sea would be catastrophic.

A simple instructional design scheme was scheme was adopted by which a rule or any of its subsets was demonstrated and explained graphically on the screen then multiple choice questions were asked about the presentation. The uniqueness of this program is that it simulated any wrong answer and animated its consequences (such as a collision).

PROPI was used to implement the lessons with the Atlas subsystem that helped with its hierarchical collection of maps to create a well controlled top-down development scheme. The external mode attribute of PROPI was extensively used to link to PC PILOT code that was created to enhance the delivery of screens and frames. The purpose of this presentation at ADCIS is to describe and demonstrate how the delivery of a classic and dry course was appreciatively improved by using interactive graphics with the help of an Authoring System.

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# PILOT IN THE LAB

## USING MENU DRIVERS FOR ADVANCED PILOT

DR. EMILE ATTALA - CAL POLY, SAN LUIS OBISPO

JAN E. FETCHO - CAL POLY, SAN LUIS OBISPO

What are the advanced features of PILOT, and how can a student learn them?

Learning enough PILOT to begin programing is easy, and the programing is rewarding. But what should be taught to the more advanced student? At Cal Poly, San Luis Obispo, we have identified several concepts that we group under the heading "Advanced PILOT". Students access various tutorials and code generators from a menu that loads when they enter the network containing PILOT.

Students learn graphics routines, sound, text animation, and program control which includes an enter key routine, user screen control, and SYSX. These are the tools that differentiate computer instruction from other instruction. The student learns to use a paint program to generate a graphic. Piq is employed from the Advanced Features Library; the Sprite Editor loads pictures into sprite tables. PROPI is used to draw with the turtle, but the student learns what each of the generated codes mean in order to correct small errors. PROPI is also used to animate the sprites and generate sound. Text animation is taught by example in a menu driven tutorial which also teaches other text methods, graphics, programing techniques, video, and record keeping. The student may choose to learn other features.

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# The Development of a PC/PILOT-Based Simulation of a Campus-Wide Information System

Blair R. Bernhardt - Lehigh University

With the installation of an IBM 4381 to provide communications services to users of Lehigh University's InteCom digital PBX came the need to provide training in the use of the IBM system. In addition to hands-on seminars, a microcomputer-based simulation of this "Network Server" environment, called NS-TUTOR, was developed in PC/PILOT to accommodate this need.

NS-TUTOR provides a simulation of logging into the system, observing the steps used to change one's password, using a "nickname" facility to simplify the use of the mail facility, and using the information facility to obtain user names and BITNET node names. In addition, a simulation of reading incoming mail and sending mail is provided within the program.

Development of this simulation provided a full evaluation of PC/PILOT as a computer-aided instruction programming language. PC/PILOT provides most of the necessary tools for simulation types of CAI, but does require a complete working knowledge of the language to be useful for simulation development. By utilizing innovative programming techniques, most shortcomings within PC/PILOT can be overcome and rather sophisticated simulations can be developed.

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# Writing Music Code With Pilot: A Tutorial

Richard G. Lambert, Georgia State University

At the 1988 ADCIS Conference, John Loomis of Kutztown State University demonstrated a technique for writing music code with the Pilot language. This program follows up his technique with a tutorial to assist the programmer in adding music to the code of any program. A file is offered that can be copied into any program that sets up the necessary statements to allow sheet music to be directly transcribed into the code. Examples of sample code are provided and the user is guided through the writing of a simple tune. A utility is also offered that can change the tempo of the tune.

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# Generating Efficient Code Using

# Standardized PILOT Routines

Benjamin H. Layne - Georgia State University

Christopher H. Kinard - Georgia State University

Most computer-based instructional systems consist of several modules related to the topic of interest. Development of a set of generalized PILOT routines while the first module is being created makes programming of subsequent modules far less painful and far more trouble-free. This presentation summarizes and describes several standardized PILOT routines which have been generated in the process of developing an instructional system in the area of statistics. A voluminous amount of PILOT code is being generated during this Georgia State University project, which has been ongoing for over two years. Because of this, use of a set of standardized routines and development tools has been essential. The PILOT code for a set of our generalized routines, which we have entitled TOOLKIT, will be distributed to those who attend the session.

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# Interactive Video in an Astronomy Laboratory

John M. Loomis - Kutztown University

Astronomy, because of its unique nature, poses a difficult problem when developing an effective laboratory experience. The traditional approach to introductory astronomy laboratories has been to resort to "paper and pencil" exercises. Many of the observations require observer skill, equipment and scheduling which is beyond the scope of a one semester introductory astronomy course.

An approach has been devised to address this problem and take the learner one step closer to the actual process of making astronomical observations. The author has written two CAI programs with PC/PILOT using a unique system of data presentation and collection. The learner is presented the data in the form of 35mm slides projected onto a rear projection screen. The learner is instructed by the CAI program in the necessary procedures for making the appropriate measurements and in the data reduction process. The measurements are made directly on the screen.

One unique aspect of this approach is the control of the 35mm slide projector. A random access slide projector (RASP) is controlled directly by the PC and the program. The learner is presented with the actual slide from which the measurements are to be taken. The interactive capabilities of PC/PILOT are utilized to analyze the results of each step. When an error has been made, either in measurement or calculation, the program branches to a diagnostic section and selects the appropriate 35mm slides to help correct the error.

Two separate CAI programs have been written and tested; 1) Rotation of the Sun and 2) Surface Features of the Moon. Preliminary results of student trials indicate that both will prove to be an effective method for presenting the concepts and data and instructingn the learner in the process of astronomical investigation. The flavor of astronomical research, if not the reality, is conveyed to the learner along with the results of the laboratory exercise.

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# Using a Mouse with PC-Pilot: Controlling Sequence, Elaboration, and Context-Sensitive Help Screens

William D. Milheim - Kent State University

With their flexibility and ease of use, mice are becoming increasingly popular as input devices for a variety of different software packages. While desktop publishing and graphics packages may receive the most benefits from these tools, there is also great potential for their use in computer assisted instruction.

The instructional uses include, for example, access to elaboration information, easy-to-use help screens, as well as one-step printing of text for later review. The use of mice also increases available learner control options through simple forward and backward page turning, single page access, and the ability to jump easily between chapters.

This presentation will focus on the instructional uses described above as shown in an instructional program authored in PC Pilot. Discussion during the presentation will include design considerations, programming options, and specific examples of the PC-Pilot commands required for using a mouse during an instructional program.

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# PILOT Methods of Processing

# Student Answers for CAI

Marianne E. Yoder* - University of Arizona

The purpose of this presentation is to demonstrate various ways to program a response to a student's answer when developing a CAI program. Answers are input in PILOT through the ACCEPT statement. Once the student inputs a response, various methods are possible to verify it and respond to it. The most efficient way to respond to a constructed response is not the most efficient way to respond to a single keypress response. Three methods of analyzing an answer and responding to it will be discussed. Programming with match statements, variable matches, and the system answer buffer will be illustrated and strengths and weaknesses of each approach will be discussed. Programming code examples for each approach also will be demonstrated.

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# NovaNET AS A STATEWIDE NETWORK IN MAINE

JAMES O. AUSTIN - UNIVERSITY OF MAINE

The University of Maine is continuing to develop a statewide CBE network using NovaNET to link public schools, vocational-technical institutes, universities, colleges and the general public. At the time of the 31st Annual ADCIS Conference, Maine NovaNET will have been operational almost two years.

Major users of NovaNET have been high schools, vocational-technical schools, adult education programs and many people from the private sector. In the last year, interest and support for NovaNET has grown dramatically.

The project report will summarize progress in the implementation of this network, focusing on recent developments and applications. A summary of costs, usage, system reliability and innovative implementations will be presented. Advantages and disadvantages of NovaNET will be discussed.

The presentation will be designed to be of particular value to persons considering a NovaNET installation, those considering other forms of computer based education and anyone interested in an overview of NovaNET from an end user perspective.

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# UPWARD BOUND'S MAINE-HAWAII CONNECTION

DEBRA L. DAVIS - UNIVERSITY OF MAINE

One hundred Maine and sixty Hawaiian high school students participated in the Maine-Hawaii Connection, a communications project utilizing NovaNET during Upward Bound's 1989 six-week summer program.

Upward Bound is an organization committed to providing educational opportunities for high school students from economically and culturally disadvantaged backgrounds. One major concern of the Upward Bound staff is the low aspirations of their students, who come from rural, isolated and low-income environments. Students view themselves as having very few education, career and social options, which are critical realms of adult development. A challenge for staff is to expose students to the many opportunities available to them so that they can make informed decisions about their futures.

Students participated in a limited-access notesfile open to Upward Bound students in both Maine and Hawaii. A self-awareness Likert scale was designed by researchers in the Education Department at the University of Maine in conjunction with the Upward Bound director, Alan Parks. This rating scale was used as a pretest-posttest measure examining how students' views of their options change as a result of interacting with people from another culture.

A description of the project, target population and results will be presented.

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# SMVTI's Commitment to NovaNET

David Pratt - Southern Maine Tech

Gail Christiansen - Southern Maine Tech

NovaNET was discovered on a local Bulletin Board System in 1987. The file description said "access the University of Maine Experimental Education network--NovaNet". This naturally piqued my interest so I downloaded the file and found a CGA computer (not an easy thing to do at that point) and called.

This was the beginning of SMVTI's relationship with NovaNET. Through the following winter, we were given author signons and spent many hours determining NovaNET's value to SMVTI. In the summer of 1988, SMVTI got off the ground by making a commitment to an RLAU with four ports to expand to eight as soon as we were ready.

ADCIS 1988 was an eye opener for us. Real faces were put to names on the computer screen and our batteries were really charged.

We returned and wildly set up curricula for the various departments as we discovered that faculty, for whatever reason, were not going to do this on their own. Gail Christiansen went on sabbatical in the spring of 1989 and did an excellent job on the curricula. [Signon as a visitor in group SMVTI and you will see.]

So where are we now? Students are beginning to use NovaNET regularly to reinforce basic skills in the summer in preparation for new courses. In the fall, NovaNET will supplement the tutoring program offered through the Learning Center. We are continuing to teach, encourage and assist faculty and students to use the system. It was slow at first and we did not expect wild enthusiasm. But NovaNET is taking hold at SMVTI.

We've come a long way in a year and a half from demonstration disk to almost 800 lessons arranged for the entire SMVTI community.

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# CONVERSION OF PLATO LESSONS TO MACINTOSH APPLICATIONS

JOHN T. SILVER, DVM, MCS*

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A system has been developed for converting lessons written in the PLATO Authoring Language into compiled Pascal programs for use on the Apple Macintosh microcomputer. Medical and veterinary lessons, some of which utilize microfiche and audio, are being translated to determine what is necessary to produce lessons which retain their PLATO functionality and take advantage of the Macintosh user interface and multimedia capabilities. A table driven translator program produces Pascal source code modules from text files containing TUTOR source code. The code modules are compiled and linked to routines which emulate TUTOR commands. The completed programs store data in 64 bit analogs of student variables and correctly emulate the sequencing and judging behavior of mainframe TUTOR. Display commands retain their original coordinates but are automatically scaled to fit the screen size. Most lessons can be installed on a file server and used by multiple users with no additional programming. Techniques are being developed to enable authors to quickly enhance translated lessons, using resources available in the Macintosh environment.

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# A REVIEW OF INTERACTIVE VIDEODISC PROJECTS DERIVED FROM UNIVERSITY CORPORATE PARTNERSHIPS

HAROLD J. BAILEY - BLOOMSBURG UNIVERSITY

CAROL LAVIX - BLOOMSBURG UNIVERSITY

Bloomsburg University, through its Institute for Interactive Technologies, has implemented a model for forming alliances with business and industry to design, develop, produce, and evaluate interactive videodisc training programs. By combining corporate, state, and university resources, a number of interactive video projects have been completed that neither group could have completed on their own. This unique model, which encourages participants from the private sector, staff from the Institute for Interactive Technologies and graduate students from an instructional technology program, will be described. Two examples of projects completed through this model will be demonstrated. The first project presented will be AIDS Education for Middle School Students, a cooperative venture between Geisinger Medical Center and Bloomsburg University. The second example will be a HyperCard application concerned with training individuals on a Computer Numerically Controlled Milling Machine used by Component Parts TEXTRON. Special Emphasis will be given to discussing program content, design considerations, and overall effectiveness.

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# DESIGN TECHNIQUES FOR REDUCING THE IVD USER'S COGNITIVE LOAD

Deborah E. Blank

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Unlike books, which have a predictable format, each interactive videodisc is a unique experience. When trainees encounter an IVD program for the first time they must perform the cognitive equivalent of patting their heads, rubbing their bellies and hopping on one foot.

The three immediate and simultaneous mental tasks they face are:

1. Understanding the program operation, including all available options.

2. Recognizing the mode of instruction and evaluation.

3. Building a subject matter schema.

This presentation will demonstrate how each of these tasks has been facilitated within an IVD program called Defensive Driving. The program was produced for Shell International Petroleum Company in the U.K. and was awarded a silver medal by the British Interactive Video Association in 1988.

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# Cost-Effective Interactive Videodisc Courseware Development: Separating Structure from Content

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**Deputy for Research**
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An article in a recent issue of the "Videodisc Monitor" cited a study that had looked at 26 interactive videodisc (IVD) projects. Out of the sponsoring organizations involved, only eight said they were ready to undertake any subsequent IVD effort. It seems safe to assume that the training need that the other 18 companies had initially identified before undertaking their first project did not suddenly disappear. So why the sudden loss of interest?

More than likely, high, up-front courseware development costs in the form of time, money, or personnel resources had too much of negative effect on subsequent cost/benefit analyses. Stated another way, given the cost, it did not make much business sense to expend further effort on interactive videodisc.

Yet not many people doubt that IVD is an attractive training alternative, that is if courseware can be produced in a cost-effective manner. How can this be done?

Work at the US Air Force Academy has shown that once a videodisc has been produced, certain basic types of courseware can be programmed at a ratio of two hours of development time to one hour of student lesson time. While no claims are made that this ratio can be replicated in all circumstances elsewhere, methods employed do have applicability in other settings. This presentation will show how software engineering principles can be applied to the courseware development problem, providing the means to reduce costs.

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# "A Right to Die? The Case of Dax Cowart"

## Using Interactive Video to Teach Moral Reasoning

Robert J. Cavalier, Ph.D.

Carnegie Mellon University

This session will demonstrate and discuss an interactive multimedia exploration of a burn patient's request to be allowed to die. The program, developed at Carnegie Mellon's Center for Design of Educational Computing, represents a serious attempt to employ new media in the service of pedagogical and theoretical goals. Its potential audience includes those in law, medicine and the health services as well as those offering diverse courses within the liberal arts curriculum.

Dax Cowart's situation poses the kind of hard choice and hard case that makes or breaks our theories about what is right, best, or decent to do. Hard cases in ethics are born of rude realities, perplexing feelings and conflicting viewpoints. But those rude realities rarely invade the groves of academe -- and studied reflection is seldom found amidst the pressures of practical life. This videodisc aims to help bridge the gap between arid theory and harried practice, to stimulate and simulate crucial conditions of critical moral reasoning in ways that other media cannot.

The videodisc program has won a Certificate of Merit in the 1988 University of Nebraska Videodisc Award Competition and Best Humanities Program in the 1989 EDUCOM/NCRIPTAL Award Competition.

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# INTERACTIVE VIDEODISC (IVD) PRODUCTION
# AND THE SUBJECT MATTER EXPERT (SME)

JAMES P. CHIAVACCI - BLOOMSBURG UNIVERSITY

DOROTHY H. HOBBIS - BLOOMSBURG UNIVERSITY

The design of a good interactive video program is a complex process which can be enhanced through coordination between the instructional design team and the subject matter expert (SME). Interactive video productions benefit from planning activities such as task analysis, learner/environment analysis, and outcome analysis. Coordination of planning activities often produces positive results while an uncoordinated effort seldom does.

At the Institute for Interactive Technologies (IIT), we utilize a team approach with SMEs from business and industry as well as the university environment. Clients have varied content backgrounds plus varied knowledge levels concerning project design and development. Because of this diversity, we quickly felt the need for a way to inform team members of the design process and to keep them on target throughout the project.

To accomplish this end, a series of Planning Agenda Sheets were developed at the Institute. These agenda sheets, along with team member responsibility forms, accompany each major step in the design model in order to execute a smooth progression through project design, development, and production.

The creation of an Interactive Videodisc Project is a complex and lengthy process and depends on a high level of understanding and cooperative efforts between the members of the design team and the Subject Matter Expert. The addition of the Planning Agenda management approach at the Institute has improved project quality and meeting production date commitments.

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# Encounters With Biology:
# Dialogues Incorporating Interactive Audio/Visual Technology

Kathleen Davey, Ph.D.
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"Encounters With Biology", a tutorial program developed for the general biology course at Ohio State, combines the flexibility of hypertext with the structure of a Socratic dialogue.

Written for the Macintosh II using Course of Action™, the program contains as an available resource, an illustrated hypertext-like glossary of terms involving gametogenesis. While browsing through the glossary, the student is invited to tutor a "classmate" on the topic of reproduction. Using digitized human speech, the computer (classmate) asks the student to explain certain concepts in reproduction and to answer some specific questions. The student responds by typing into an online notepad. The dialogue encourages the student to use information contained in the glossary to reason about that which is unknown to him or her.

Questions asked of the student range from a few fixed choice and verification questions to more open ended questions. At the end of each dialogue segment, the student is asked to enter a sentence summarizing the main topic of that dialogue. Upon completing a sentence that includes the key points discussed, the classmate paraphrases the statement and leaves the student alone to continue browsing through the glossary.

Results of the evaluation of the program's effectiveness and its implications for future development will be discussed.

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# FORMATIVE EVALUATION OF INTERACTIVE VIDEODISC

Maureen D. Foelber

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Although researchers have produced a significant number of evaluation reports of interactive videodisc (IVD) projects in the past few years, most of the reports contain few descriptive details and have been published in journals with small readerships or are private reports. It is likely that many designers of IVD have not been able to utilize lessons learned by other producers of IVD.

The non-linear "branching" nature of IVD challenges the instructional designer to try and anticipate user reactions to the material. In addition, IVD combines the flexibility of a changeable computer program with the inflexibility of a permanently pressed disc containing still and motion videos. Since user reaction can never be wholly anticipated and, once pressed, the disc cannot be modified, formative revision of the product is critical and likely to be substantive. Thus, the importance of establishing criteria for revision cannot be underestimated.

This paper addresses six areas of consideration for formative evaluation of IVD which include: using system-and non-system generated data; exploring levels of interactivity; generating a workable timeline for evaluation; asking specific questions about learner control; enhancing the development of "expert" judgement; and addressing potential ethical concerns.

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# Development and Demonstration of Science

# Tools for Interactive Video

Michael E. Hale
Russell H. Yeany
Kent Gustafson

University of Georgia

The purpose of this presentation is to report the progress made to develop interactive science software tools. The student or teacher could use the software tools to make measurements of videotape phenomena and to analyze interactively the relations found within their measurements. The tools function in an intuitive object oriented interface, which overlays video of science phenomena. The presentation will include a discussion of the rationale for the selection of a programming language for the development instead of an authoring system. A short demonstration of the tools will be conducted using a generic science videodisc. Current research studies using the software will be discussed.

Many experts are stating the need for improved science instruction and the availability of interactive multimedia technologies can provide a powerful environment for student learning. Many science phenomenons such as the path of a falling object occur too rapidly to be observed in detail with the human eye. Generic videodiscs or student-made videotapes become captured databases to be analyzed by students or teachers. In the traditional science classroom these rapid phenomenons would be measured indirectly. To disassociate measurements from the visual science phenomena requires the student to connect mentally the measurement to the phenomena. Students, using interactive video technology, can make a more direct association between the physical phenomena and any measurements or abstract concept such as vector.

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# A QUALITATIVE APPROACH TO THE DEVELOPMENT OF THEMATIC ICONS FOR A HEALTH CARE IVD TRAINING PROGRAM

JORDANA R. HUCHITAL

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Several themes in a national program to train nurse assistants in long term care facilities reflect critical job-related concepts. Because most of these themes apply to several content modules in the multiple videodisc program, designers recognized the need to reinforce the concepts through visual cues such as icons. The program's themes include ideas such as respecting residents' rights and observing infection control measures.

The design challenge was to create visual cues that could speak effectively to the program's audience. A three-stage formative evaluation process began with small groups of nurse assistants who played a game creating pictures of their own mental images for these ideas. During this process, the nurse assistants also reviewed and validated the importance and relevance of the concepts with design team members. Following execution by a graphic artist, the communicative power of preliminary icons was tested in reviews by additional nurse assistants. Polished icons were then exposed to a third group.

The success of the thematic icons will be tested through a trainee survey embedded in the videodisc program. Additional evaluative research is being considered to compare the use of the program with and without icons.

This presentation will report on the formative evaluation process undertaken in this project and the design for trainee survey and related research.

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# From Art History to the Art and Science of Medicine: Interactive Video at the University of Iowa

Joan Sustik Huntley
The University of Iowa

Since 1978 the University of Iowa has developed interactive videodisc programs in higher education. Application modes include:

*tutorials :* Pediatrics, Nursing, Ophthalmology, Genetics, Psychiatry
*visual databases :* Art History, Urology, and Literature
*patient education and training :* Gynecology and Otolaryngology
*simulations :* Film / Broadcasting and Dentistry
*drill and practice :* Ballet, Foreign Language
*information kiosks :* the University Hospital and the College of Education

The technical platform has matured from a Small Apple to a Big Mac - from 16k Apple II's to 4 megabyte MacII's with digital video as well as InfoWindow systems. The staff is better organized and more efficient. Nevertheless, every new project is still a challenge. Just as babies have to be approached anew since they have their own unique personality, interests, and competencies, so must interactive projects be individually considered and nurtured.

My talk will present video segments, discuss successes, admit failures, share frustrations, and acknowledge rewards. I will describe conditions which have helped support the diverse development in what might superficially appear an unlikely place to pioneer interactive video: a state university in the heart of the midwest. But in the recent film *Field of Dreams*, Shoeless Joe asked "Is this Heaven?" and Kevin Costner replied "No, it's Iowa". There must be something out there.

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# IVD: Retraining the Older Worker

John W. Irving - DISCUS Electronic Training

There are important economic, business, and social reasons for retraining older workers (defined here and in most research as workers of age 40 or older). Interactive videodisc (IVD) is a particularly appropriate means for effective and efficient retraining. A number of special factors must be considered in the design of IVD programs for older workers; as always, design is critical to the success of IVD training.

There has been massive movement from manufacturing to service industries in U.S. employment, forcing hundreds of thousands of older workers to seek new jobs in unfamiliar skill areas. Baby boomers are moving en masse into the category of older workers, while employers confront a declining pool of younger workers. The nation can ill afford large numbers of displaced workers. Retraining will benefit workers, employers, and the economy by maximizing utilization of human resources.

IVD provides distinct benefits in retraining in several areas. Ergonomically, IVD accommodates the physiological limitations of older workers, such as declining visual and auditory acuity. The technology answers concerns regarding psychological and emotional factors; providing, for example, great flexibility in determining the path and pace of training, and feedback tailored to the responses of individual trainees. IVD allows highly flexible training schedules, and the means to present standardized material while permitting workers to "individualize" their training program. Importantly for employers, IVD may be more economical than classroom training and more effective than linear video where large numbers of workers must be trained in standardized tasks or procedures.

When IVD is considered for retraining older workers, designers should assure that the program takes advantage of trainees' past knowledge and experience. Design should take into account possible lack of experience with computers and computer-based applications, and human support should be readily available to avoid feelings of being "cut off" or overwhelmed by technology.

When design factors are properly addressed, the strengths of IVD provide great potential for economical, effective retraining of large numbers of older workers in new skill areas.

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# A HYPERCARD GUIDE: FACTORS TO CONSIDER WHEN DESIGNING CBIV

Karen Lee Jost, Barbara Grabowski - Syracuse University

David Dalton - The Florida State University

When designing or evaluating computer-based interactive video, many factors should be considered. It is also important to focus on how these factors may interact and effect learner comprehension of the presentation. Even though lesson design logic is considered to be of primary importance, appropriate presentation stimuli and the organization of stimuli in effective ways, can influence affective responses to instruction, how learning occurs, and whether meaningful processing may occur.

We are developing a hypercard guide for designing and evaluating CBIV. The factors that influence the effectiveness of CBIV have been categorized as follows: learner variables, content, instructional design, message design, program design, and environment. Each category is then further developed. For example, message design is subdivided into: visual/screen design; effective use of computer; effective use of video/film; effective use of audio; and effective use of animation (film or computer generated). Each of these subcategories is then further divided and elaborated. The user can request explanations, definitions, and examples. The program can branch to the particular design specifications required for effective, tutorials, drills, simulations, or games.

The final product includes a tutorial using a video stack to present examples. It also includes a set of resources for designing CBIV. The resources include a database of authors and relevant abstracts.

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# Interactive Videodisc As an Informational/Promotional Tool in Higher Education

Mable B. Kinzie, Ph.D.
Virginia A. Scott, M.Ed.
Maureen D. Foelber, M.Ed.

The University of Virginia

Interactive videodisc (IVD) technology is uniquely suited both for the delivery of information and for promotion/enhancing public relations. This presentation will describe the development of such an interactive program for a school of Education at a major university.

Like much of the interactive development undertaken within the field of Education, this program was developed with a minimal budget--besides completing all of the production work in-house, only one-half of one side of a videodisc was available. In order to maximize the program's scope and effectiveness, particular emphasis was placed on the use of still videodisc frames, computer generated text and graphics, and synthesized speech, along with full-motion videodisc segments.

The program is designed to be explored by visitors to the school as well as potential students. The presentation will include demonstrations of the interactive program, and will offer recommendations based on formative evaluation for designers and academicians.

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# CREATING YOUR OWN INTERACTIVE VIDEO LESSON

Lynne Levy and Louis Molinari

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The classroom computer has become a permanent fixture in many educational settings. The functional role it plays, however, is dependent upon the computer expertise of the classroom teacher, the time the teacher devotes to lesson preparation, and the peripherals available. When correctly used, this technology can produce effective lessons.

This same computer can be expanded into a tool to create dynamic and worthwhile learning environments. With some effort and lots of time, the classroom teacher can create, design, and organize quality interactive educational lessons utilizing authoring software which puts the computer and laserdisc player together as one effective delivery system.

Interactivity can be accomplished inexpensively utilizing the Apple II series of computers (as well as others), along with a laserdisc player and interface, educational video discs and authoring software. The teacher need not be a programmer; authoring software provides the teacher with step-by-step instructions for lesson preparation.

Three authoring programs for the Apple II computers, which utilize the video disc to provide interactive video, are LaserWorks, ImageWorks and Tutor-Tech. ImageWorks provides complete control of the laserdisc player through AppleWorks, combining the capabilities of AppleWorks with data on a video disc. LaserWorks and Tutor-Tech (a hypermedia product), serve as authoring programs which allow the teacher to create interactive lessons and presentations with the video disc. With the marriage of the technologies not only can the teacher present effective lessons, but create and control dynamic learning environments.

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# Preparing School Principals For Professional Practice Through Interactive Video

David A. Mappin, University of Alberta

R. Gordon Mcintosh, University of Alberta

University preparation programs for educational administrators have been criticized for being 'too theoretical', despite their widespread acceptance. Traditional classroom-based instructional approaches have made the transfer of theory into practice difficult.

In thinking about alternate methods of preparing administrators, such as school principals, to move from theory to practice, academics in educational administration bring to the process a set of theory and traditions which differ from those brought by an instructional technologist. Administrator educators talk with reference to such concepts as clinical training (internships), case studies, and experiential learning. Instructional technologists express their ideas in terms of systematic design processes, instructional objectives, and cognitive psychology.

Our group began by the instructional technologist listening to the ideas of the educational administrators. Using a lock step instructional development model was avoided. There was information to be shared related to the technical possibilities for creating solutions. There were no practical technical solutions to some of the desired interchanges and proactive problem solving which were desired. While problem solving was the focus chosen, precisely defining the boundaries of the problems was undesirable.

Several factors contributed to the establishment of a successful working relationship in this instance:

1. Time. The project encompassed enough time to permit both groups to come to a more mutual understanding.
2. A willingness on the part of both groups to respect the different approaches of different disciplines and to accept some compromises.
3. Recognizing that the most effective learning system combined the use of interactive video simulations with other instructional activities.
4. Realizing that there were areas of conceptual common ground.

The result of the collaboration was a 39 hour graduate level course entitled, 'The School Principalship: Simulations and Seminar'.

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# DESIGNING FOR INTERACTIVE VIDEODISC:

# THE PROCESS OF "CHUNKING"

SUSAN A. MATTSON - FLORIDA STATE UNIVERSITY

By integrating and pushing the capabilities of emerging computer-based technologies, the computer can be a rich educational resource. One promising application of this resource is the creation of complex learning environments that simulate data gathering in the real world. These microworlds can incorporate a diversity of computer capabilities and can address learning objectives that cross a range of cognitive domains.

Designers of these types of environments face the process of "chunking" through all phases of a project. Chunking is defined here as the embodiment of abstract goals and objectives to the medium in some way. Chunks can take the form of still or motion video, audio, graphics, animations, and even specific interactive events. Each chunk, in turn, can have various dimensions that are partly determined by the nature of the medium, and partly by the goals and objectives of the designer.

Thus far, very little attention has been paid to chunking as a formal process when designing for interactive videodisc. The purpose of this presentation is to discuss chunking as experienced in designing videodiscs for the Interactive Media Science Project at Florida State University.

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# A COMPARISON OF INTERACTIVE VIDEO HARDWARE/SOFTWARE TOOLS

WILLIAM D. MILHEIM - BLOOMSBURG UNIVERSITY

KENNETH A. JOB, JR. - BLOOMSBURG UNIVERSITY

There are a number of authoring systems/languages that exist for a variety of hardware/software configurations. Each of these hardware/software systems has its own strengths and weaknesses which leave the developers of interactive videodisc courseware in a quandary. The Institute for Interactive Technologies at Bloomsburg University has developed a number of interactive video programs on a variety of hardware/software configuration. The purpose of this session is to demonstrate, through these programs, the capabilities of several of these systems. Attendees will also have the opportunity to explore, through brief "hands-on" activities, authoring tools such as Mentor and Course Builder on the Macintosh computer, and Quest and OASYS on an IBM InfoWindow system. The session will end with a critique that will highlight the advantages and disadvantages of Mentor, Course Builder, HyperCard, Quest, OASYS, Genesis and IMSATT on their respective hardware systems.

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# The Use of Prescriptive Video and Feedback Strategies

# In a Nutrition Promotion Project

John F. Moore*, Richard A. Winett, Jana Wagner, Tamara Neubauer,
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The *Nutrition for a Lifetime System* research project is studying the efficacy of interactive video and feedback techniques to promote shifts in consumer food purchase and consumption practices. The research uses a true experimental design to examine the utility of stand-alone interactive information kiosks in supermarkets to help consumers meet National Cancer Institute dietary guidelines for reducing fat and increasing fiber intake.

The strategy includes video-based prescriptive and modeling segments coupled with individualized feedback concerning progress in reaching goals in specific food categories. The research takes place over a baseline shopping period, an intervention period, and a follow-up. All subjects provide both their intended food purchases (on special "shopping list" op-scan sheets which are read by the system) and also their cash register receipts showing actual purchases. During the intervention period, subjects in the treatment condition see weekly video segments which follow a gradual step-by-step prescriptive approach and use touchscreen sequences for commitment strategies and choices of optional branch information. During intervention, subjects also receive printed feedback regarding their intended purchases and a printed shopping list arranged to match store layout. The shopping list printout includes suggested product substitutions. The feedback analysis notes shifts in purchase plans for specific food items related to past shoppings. Actual food purchases, taken from register receipts, are later compared to subject's touchscreen commitments and intended purchases.

Data from the first field study indicates consumers did make shifts in certain food categories (e.g. high-fat meats) consistent with the nutrition messages promoted through the system. Instructional design issues, system modifications, consumer reactions, and information on continuing research will be presented.

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# USING INTERACTIVE VIDEODISC TO TEACH MEDICATION ADMINISTRATION TO NURSING STUDENTS

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Interactive videodisc technology provides a potentially exciting medium for teaching psychomotor clinical skills to health care professionals. It appears to hold particular value for teaching complex skills which involve both visualization of motor activities and extensive client assessments.

An interactive videodisc program was developed at Thomas Jefferson University to assist nurses and other health care professionals in acquiring the knowledge base and psychomotor skills necessary to safely and effectively administer therapeutic agents to clients. The program, which is being developed for the IBM InfoWindow System, will facilitate decision making related to the entire process of medication administration. This process includes interpretation and transcription of medical orders, client assessment, dosage calculation, administration of oral, topical and parenteral medications, documentation of actions, and related legal issues.

During the development of this program several problems emerged. For example, it was relatively easy to apply interactive video principles to the cognitive/decision making portion of the program. However, the motor aspects of learning a skill, such as tactile sensations, were a great deal more difficult to incorporate in a meaningful way.

This presentation will involve a demonstration of the portions of the program which teach the administration of oral and parenteral medications and a discussion of the strengths and weaknesses of the use of interactive videodisc technololgy to teach psychomotor skills.

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# Individualized Interactive Instruction for Distance Learners:

# Design and Development of Computer-Assisted Interactive Video

Mioko Saito - University of Oklahoma

Charlotte N. Gunawardena, Ph.D. - University of New Mexico

Computer-Assisted Interactive Video (CAIV) has been hailed as a medium that has great potential for distance education with its ability to maximize the opportunity for delivery of individualized, interactive instruction affording the learner significant control over the medium. The development of CAIV for education and training, however, is still at an experimental stage. In most instructional designs for CAIV, the tendency has been to focus design on the technical attributes of the new medium rather than on principles derived from theories of learning and instruction for the systematic design of instruction.

Therefore, this paper attempts to discuss a framework for the design and development of CAIV that is based on theories of learning and instructional design focusing on techniques that can facilitate distance students' learning from CAIV instruction. The discussion draws on design principles derived from both behaviorist and cognitive learning theories especially recent research on information processing, and the design experience gained by the authors during their involvement as instructional designers in three CAIV projects. In one project, a CAIV package was developed for a college level French course to be offered to off-campus students. The other two projects were designed to teach the functioning of a hydraulic system to students at a vocational-technical institute and the use of a copy stand to college students using the Instructional Services Center. All three projects used pre-produced videotapes.

The design and development of CAIV is discussed in terms of macro and micro design considerations. Macro considerations include the following phases: a) needs assessment, b) design instruction, c) development and implementation, and d) evaluation and revision.

Micro design considerations include a discussion of: a) the design of instructional events to facilitate internal learning processes; b) the design of interactions for a CAIV system and the adaptation of these interactions to suit learner characteristics; c) learner control vs. program control over lesson sequence and the implications of learner control options for adult learners; and d) the design of feedback.

# The Effects of Interactive Videodisc Cognitive Achievement and Attitude Toward Learning

Schare, B.; Dunn, S.; Clark, H.;

Gilman, B.; & Soled, S.

The purpose of this experimentally designed study was to determine the effects of an interactive videodisc program versus traditional lecture on cognitive learning and affective behaviors. The Level III interactive program, "Diabetic Health Assessment", was investigator-developed.

It was hypothesized that: (1) there would be no significant differences in the cognitive achievement scores between those students taught by a traditional lecture method, and (2) statistically significant differences would be obtained between those students taught by an interactive videodisc program as compared to students taught by a traditional lecture method in their attitude toward learning. Eighty-three third year baccalaureate nursing students at a major urban university served as subjects and were randomly assigned to either a control ($\underline{n}$=41) or an experimental group ($\underline{n}$=42).

The multivariate analysis of covariance with two criteria and pretest as the covariate was significant ($\underline{p}$=.000, df=4,140). The univariate $\underline{F}$ for the cognitive measure was nonsignificant ($\underline{p}$=.283, df=2,72) indicating that students' achievement under interactive video was not significantly different than under traditional lecture. The univariate $\underline{F}$ for the affective measure was significant ($\underline{p}$=.000, df=2,72) indicating that the students' learning by interactive video possessed a more positive attitude toward learning.

This presentation will include a discussion of the research findings. In addition related portions of the program will be used to illustrate the learning potential of interactive videodisc.

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# Audio Visual Combinations and Their Effect Upon the Computer Controlled Audio Visual Message

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Certain combinations of words and pictures can create a different technical message than other combinations of the same words and pictures.

The combination, verbal/verbal, uses two sensory channels to convey the same message. The verbal/iconic combination uses the verbal portion to expand the message presented by a visual illustration. The non-verbal picture poetry combination invokes emotion and feelings. The non-verbal/picture poetry combination guides an audience toward a connotative meaning. A non-verbal/non-pictorial display is usually some type of abstract design; this can serve to get the audience's attention or it can be used as a background. The exaggerated verbal/normal pictorial combination refers to the sudden increase in volume of the sound accompanying the visual. Care must be used with this technique. It is also possible to exaggerate specific portions of an illustration. This normal verbal/exaggerated pictorial combination calls attention to a particular aspect of an illustration. The normal verbal/pictorial analogy combination uses a picture of one thing to illustrate how another concept works. The combination normal verbal/visual cue emphasis emphasizes particular cues with shading, outlining, or the use of pointers.

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# INTERACTIVE VIDEODISC APPROACHES FOR TEACHING SIGN LANGUAGE

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For several years, students in an introductory course in Sign Language at Bloomsburg University have asked that their instructor videotape the various sign vocabulary presented in class so that they might view and review signs taught by their professors. Videotapes, however, have been found to be quite slow because of the required rewind time, thus forcing students to view signs in a linear mode.

To fulfill this need and solve the time problem, professors from Bloomsburg University in the Departments of Communication Disorders, Special Education and the Institute for Interactive Technologies worked together to produce an interactive videodisc approach to the teaching of Sign Language. Used as a supplement to the regular class time, this approach provides the student with a "visual book" of signs taught by the instructor. Using an Apple Macintosh microcomputer, a Panasonic TQ-2024F optical disc player, and HyperCard, students are able to observe a signer presenting signs using a simultaneous front and side view split-screen format on a TV monitor. Immediately preceding the presentation of the sign, the student is presented with a textual explanation, on the computer screen, of how the sign is produced.

Through this interactive videodisc approach, students are exposed to 80 fingerspelled words and 652 signs. Students are given a "menu" of choices from which to select the desired sign or fingerspelled word they wish to see, and in less than 1/2 second, the sign is presented. At the end of each of ten categories, students have the option to work through a random sampling of signs and fingerspellings for self-evaluation.

The program also contains 270 sentences divided into the same categories presented in the "vocabulary" section. These sentences are presented in both ASL and PSE.

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# From Idea To Production: The CD-ROM School Disc

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## ABSTRACT

The CD-ROM School Disc was designed and produced by doctoral students in the Educational Technology Program at Lehigh University. It's purpose was to provide a meaningful learning exercise for utilizing CD audio, sound, graphics, animation, and text in a common medium for the delivery and evaluation of educational courseware and educational databases.

The School Disc contains approximately 525 megabytes of information formatted in Macintosh hierarchial file structures (HFS) and High Sierra PC/MS Dos Structural files. Data on the disc include a variety of applications using all media formats with the exception of digitized real-time motion video. That is, the disc contains text databases, color and black and white images, animation, CD audio, other digitized sounds, and digitized 35mm slides. The following educational applications are included on the Disc; HypeArt, Roger's Birthday Party, The LaserGallery, Visual Effects, HyperMusic, Images and Graphics, The ITEC Stack, and The School Law Stack.

The production of the CD-ROM School Disc involved the following activities:

1. Identification of various multimedia educational applications and databases as candidates for inclusion on disc.
2. Determine technical requirements and formats for submission of data (sound, images and text) for mastering by a CD-ROM production facility.
3. Prepare data and formats for CD-ROM production.
4. Design disc label for submission to CD-ROM mastering facility.
5. Conduct evaluation of check disc for errors and accuracy.
6. Produce disc in quantity for distribution.

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# THE REPURPOSING OF RAIDERS OF THE LOST ARK: HYPERCARD DESIGN AND RESEARCH ON CLASSROOM USE

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Interactive videodisc technology offers the teacher access to a wide variety of images in still frames or motion sequences to provide material for content lessons. Although the availability of commerical videodiscs designed for instruction is increasing, the repurposing of feature films or image discs provides the teacher possibilities for developing highly motivating lessons to assist students in building a knowledge base for specific content and in developing pre-requisite structural and organizational skills.

This presentation will discuss the use of Hypercard to create a unit on the organizational skill of sequencing. The Hypercard scripts use a combination of videodisc segments and computer display to provide practice and feedback and to track student performance data. These scripts, which can serve as templates for programs in a variety of content areas, will be demonstrated.

In addition to program features, we will also present data from research with ninth grade students. A qualitative study is currently being conducted which examines the effects of program use. Observations are focusing on reaction of the students to the program, ease of use by the students, interaction of students using the program together, and effects of program use on the classroom ecology. A discussion of the results will focus on implications for future repurposing projects with the use of Hypercard and popular movies.

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# REDESIGNING PRINT-BASED SELF-STUDY PROGRAMMER TRAINING FOR INTERACTIVE VIDEO

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Interactive video's ability to focus attention on management or sales behaviors through video scenarios and student decision making is well displayed at any courseware exhibit. A comparatively less exciting subject, programmer training for an IBM mainframe operating system, can also benefit significantly from the combination of presentation and practice/feedback/testing strategies that a level three program permits.

This presentation will specify the design process and instructional strategies used in the redesign of Science Research Associates print based, self-study courses for computer programmers. Data summarizing one year of field use of these products will also be presented.

The interactive video version of each course was a dynamic tutorial that included live action video, video animation, enhanced computer graphics, and two track audio.

Throughout each course, custom designed and traditional question formats tested student comprehension of the subject matter and provided extensive remediation for misunderstood areas. These questioning techniques included realistic coding problems, identification and correction of incorrect coding, concept identification, rule demonstration, sequencing, matching, completion, and multiple choice.

Extensive learner control features were designed into all segments of the courses. Learners of differing levels of personal computer and interactive video literacy were able to successfully operate the courses and utilize the control features.

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# DISCRIMINATION ERRORS AND LEARNING TIME IN COMPUTER DRILLS

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An unresolved issue in drills is whether to group similar items or separate t Drills with dissimilar items may reduce discrimination errors and learning ti while with similar items confront learners with discriminations they must eventually encounter, so may be better for retention.

Thirty three college students were subjects. PAIR subjects had similar words grouped, NONPAIR had similar words separated. All studied the same 10 pairs of similarly spelled Chinese words. The PAIR group received 5 pairs on Monday and the other 5 Tuesday. The NONPAIR group received 10 dissimilar words on Monday and their corresponding pairs Tuesday. Eight pairs were reviewed by everyone on Thursday.

Number of discrimination errors and time to mastery for the first two days were summed and MANOVA repeated measures analysis showed PAIR subjects made more errors, F(1,31)=4.4, p=0.0441. On Thursday the difference was smaller and reversed, F(1,31)=0.4, p=0.5341. PAIR subjects reduced their errors on the review drill more than NONPAIR subjects, F(1,31)=12.22, p=0.0014. The group effect on time was similar but not significant.

The results suggest similar words in a session increase errors and time initially, but benefit retention.

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# Lewis Dot Program Design Techniques

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The program represents the student by a list of skills needed to draw Lewis structures correctly. The list of skills was developed by observing students, talking to instructors, and by reading logs of student actions with a drill-and-practice predecessor program. We tested the accuracy of the skill list by

(1) grouping the molecules by skills thought to be required and
(2) looking at average student performance for each group on predecessor program.

In these tests, performance within groups was uniform. This is good indirect evidence that (1) no skills were unidentified and (2) molecules have been properly matched to skills.

This analysis of student performance allowed us to rank skills and molecules by difficulty. The current program now moves a student from one task to the next based on this ranking.

Both of the following time-consuming techniques were less helpful and were abandoned because of a tight deadline:

(1) Protocol analysis of videotapes of student actions with the predecessor program. Despite prompting, students did not verbalize their thoughts well during videotaping.
(2) Constructing "problem behavior graphs" of student actions. (cf, Newell and Simon, "Human Problem Solving"). The graphs would be transformed into rules executable in a production system. We were unable to draw them efficiently. Also, we could not represent student iteration and backtracking in the graphs.

Since fall, 1988, we have run two pilots of the program, using about 75 subjects. These sessions have turned up a number of bugs and some design problems, all of which we probably would have missed in laboratory designer/programmer testing. We conclude that such piloting is crucial to ensuring final program quality.

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# THE EFFECTS OF QUESTIONING METHODS AND LOCUS OF CONTROL ON LEARNING FROM COMPUTER-ASSISTED INSTRUCTION

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Students can sometimes perceive influences affecting their lives as internal (those that are under their control) and external (those that are beyond their control). Generally, computer-assisted instruction has taken a somewhat linear and external approach to instruction: students go through a series of programmed learning based on designer-influenced criteria. This traditional approach rarely takes into account prior knowledge that students may possess.

A cognitive approach towards instruction, however, could activate existing knowledge structures that students may possess and would help lead to more meaningful processing and deeper understanding.

Our research has focused on the effects of cognitive versus behavioral-oriented questioning strategies. Behavioral questioning strategies are primarily linear and are context bound. Cognitive questioning strategies, on the other hand, are centered around existing information that the students may possess. The development of strategies that tie new knowledge with existing information that the learner may possess will hopefully lead to more meaningful learning and a better understanding of the material.

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# The Use of Text-Based Hints in Improving Learning via the Computer

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Terrance Ahern, Pennsylvania State University

The effects of using text-based hints to stimulate learning new information in college-aged subjects were studied. The study investigated individual subject's ability to learn new mathematical information.

One hundred twenty-one subjects worked independently to learn and master new mathematical information. The information was presented in a computer-based lesson which instructed subjects in the values, rules, operations and procedures to be used in evaluating strings of mathematical symbols. Students were tested for mastery prior to proceeding to computational problems.

After mastery, students were presented with computational problems and either received partial or full control in accessing text-based hints in solving the computational problems. Subjects were divided into four treatment groups, learner control with full hints, learner control with partial hints, lesson imposed with partial hints and lesson imposed with full hints.

Additionally, the mastery and computational content was broken into three catagories of question types, facts, application of rules and problem-solving.

Significance testing for long-term retention between groups was performed. Although no overall significant results were found, retention was best for subjects who received lesson imposed (partial) hints for fact based content.

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# FEEDBACK AS INFORMATION AND INTERACTION

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Feedback is a critical component of CBI. But, its benefit to the student, both as a source of information and a form of interactivity, is dependent upon the way it is designed. While previous studies have distinguished between motivational and informational feedback, this research operationalized feedback strictly in terms of information value. Six different feedback conditions representing increasing amounts of information to the student (No Feedback, Redundant Feedback, Reward, Punishment, Knowledge of Correct Response, Punishement and Knowledge of Correct Response) were manipulated to assess their impact on student performance during a CBI lesson on vocabulary building.

It was found that students receiving the three higher levels of information performed significantly better than those receiving the two lower levels. In addition, no difference was found between students receiving redundant feedback and no feedback, suggesting that interaction for interaction's sake is not an inherent advantage of CBI. A replication of the study on a shorter version of the lesson failed to show any significant differences among the various feedback conditions.

No longer should educators be concerned about the presence or absence of feedback in CBI, but rather concern should focus on its informational content and the manner in which it is displayed.

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# TOWARDS A CONCEPTUAL FRAMEWORK FOR THE DEVELOPMENT AND UTILIZATION OF COMPUTER-ENHANCED LEARNING SYSTEMS

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The selection of appropriate modes of instructional computing technology should be, in an ideal world, based on theoretical principles designed to maximize the student's knowledge acquisition and thinking skills. Unfortunately the theoretical bases underlying the different modes of instructional computing are poorly articulated at present, so that researchers, courseware developers, and educators must frequently rely on implicit or intuitive notions in their utilization of technologically-oriented educational systems. As a first step towards the development of a comprehensive theoretical view, this presentation proposes a conceptual framework for analyzing and employing instructional computing technologies.

We refer to the entire range of instructional computing use--both traditional computer-based instruction modes (such as tutorial, drill and practice, and simulation), tool uses of computers (word processing, spreadsheets, etc.), and cognitively-based educational devices (such as intelligent tutoring systems, microworlds, hypermedia, and empowering environments)--as *computer-enhanced learning systems*. These different instructional computing modes of use are situated along three dimensions: domain structuredness (well- versus ill-structured), domain complexity (simple versus complex), and the learner's stage of knowledge acquisition (novice, advanced, expert).

This conceptual framework for computer-enhanced learning systems should be useful to researchers, developers, and educators as it provides: 1) a descriptive understanding of common practices and empirical findings in the field and 2) prescriptive guidance towards the development and utilization of existing and emerging computer-enhanced learning devices. We also hope that this framework may contribute towards the philosophical and theoretical foundations of the instructional computing field.

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# An Algorithm for Computerised Drill & Practice

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The potential of computers as an aid to memorization of rote learning tasks is tremendous. It is possible to exploit its capabilities such as graphics, randomization, record keeping, unlimited iterations and conditional specifications to bring about optimal memorization. This presentation describes a package based on an algorithm which takes advantage of the above capabilities. The algorithm is based on a concept of the Storage, Presentation, Review and Learned item pools. The items to be memorized move between these pools depending on the learner's response, size of the review pools and criteria for mastery fixed for various levels by the 'instructor'. A simple game is incorporated in the design of this package to add an element of 'fun' to learning.

A study was conducted to examine the relative effectiveness of the conventional and computerised memorization strategies. Computerised strategy was found to be more effective for both short term and long term retention but only if the mastery criterion is set at a higher level. Issues related to fatigue, attitudes, inter-item interference, computuer games and time involvement which need further examination are also discussed.

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# DEVELOPING AND DESIGNING A HANDBOOK FOR USER CENTERED COMPUTER INTERFACES

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Software interface guidelines and human factors research have become important to the designers of user center interfaces. The need for users to access the capabilities of computer software requires that interface designers need to know what the important issues in interface design are and how to implement them in their interface designs. There are many books and papers detailing the research in human factors and providing thousands of guidelines based on the research. These resources help the interface designer keep on the right track in developing efficient interfaces. The use of research findings and subject matter experts is in agreement with an instructional design perspective and may provide a design environment that produces the ultimate interface design that promotes learning and efficiency using computer software.

While user-centered interface designs promote the learning of instructional software, they pose serious problems for the designer and the software development group. As with most user designed interfaces, the more user friendly to users with different characteristics, the greater the level of expertise required of the interface designer. To design an efficient and user centered interface requires that the designer sort through numerous research papers and guideline documents. This can become a very difficult and time consuming task. Additionally, some guidelines that seem common sense are not always supported by the research in the field. The selection of the appropriate research based guidelines, designing a user centered interface with the proper computer delivery system and meeting project deadlines makes the design process a definite challenge to the interface designer.

This presentation is designed for those who have an interest in designing of a User-Centered Interface Guidelines Handbook. This instructional aid was designed for people that are currently involved in designing computer interfaces for products that will be used for instructional purposes. The aid is based on the research in the field of human factors knowledge as it applies to user-centered computer interfaces. Based on our experience with working with different interface designs, we will also address what was involved with designing the instructional training aid, offer helpful techniques and design strategies, and provide a short summary of the evaluation results.

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# IS USER PERFORMANCE A FACTOR OF COMPUTER BASED INSTRUCTION PACING?

DONALD E. KLINE - LEHIGH UNIVERSITY

The effect of user controlled pacing of computer based instruction has been called into question by several studies. A project designed to gather additional data on this question has been carried out using 180 secondary school students from grades eleven and twelve. Each subject received a computer administered pretest, treatment, and posttest. The experimental design was a 2 X 4 design with two dependent variables and two covariates. The independent variables were verbal processing time and pictorial processing time, with pretest and posttest scores as the dependent variables. The covariate factors were subject IQ and reading level.

To determine if the presentation rate had an effect on subject performance, four different pacing speeds were used. They were: base rate corresponding to a reading speed of 300 words per minute, base rate plus seven seconds, base rate plus fourteen seconds, and base rate plus unlimited subject time.

An ANOVA analysis indicated that only the covariate factors had any effect on the subject's performance.

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# Comparing CBI and Other Instructional Techniques

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During the past ten years, the microcomputer has become increasingly important as an instructional medium. In fact, Roblyer (1988) identified over 160 published and unpublished studies related to the effectiveness of microcomputers in education, all of which were performed since 1980. As Roblyer emphasizes, evidence of the impact of CBI on traditional measures of educational effectiveness becomes more important as more computers are available in educational settings. Guidelines for performing evaluative CBI research in this presentation. Eleven items which should be considered prior to conducting a CBI evaluative study will be enumerated and discussed. Even though these items will be related specifically to research in the public schools, they are appropriate in almost any setting. In addition, two specific CBI evaluative studies will be described. The first, which was performed in a public school setting, was sabotaged due to lack of consideration of the aforementioned items. The second study, which was an attempt to perform an unconfounded CBI evaluative study, was conducted in a college classroom setting.

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# COMPUTER ANSWER JUDGING AND ITS EFFECT IN LEARNING

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As more instruction is delivered via computer, it becomes increasingly important to improve the learning and retention of information presented in this manner. Evaluation in early computer-assisted instruction (CAI) involved mainly true/false and multiple choice answers. As lesson design improves and more open ended questions are asked, it is increasingly important to develop new evaluation models. There are two major advantages to providing computerized answer judging. First, the instructor can be freed from the task of examining correct answers and can spend more time evaluating responses gauged as incorrect to see more clearly where the learners' weaknesses lie. Second, CAI based answer judging gives the student the opportunity to respond to answers considered incorrect, a process which may contribute to learning and retention.

This study examined the effects of four levels of reaction to computer-assisted answer judging. A control group experienced conventional response feedback, being informed of the correctness and seeing a correct answer. A second group received conventional feedback, and had the option to "agree" or "disagree" with the feedback by "clicking a button" on the computer screen. A third group received feedback and had the option to respond to the feedback in writing. A fourth group received the feedback, and had the option to "agree" or "disagree" with the feedback as well as the option to respond. This answer judging model gave the student the opportunity to experience cognitive dissonance by receiving feedback, and may have strengthened learning when students defended a response considered incorrect.

The data are presently being analyzed and analysis will be completed by the date of the conference.

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# ID Expert: A Progress Report

M. David Merrill, Zhongmin Li, & Mark K. Jones

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ID Expert is an expert system which guides the instructional design process. It is implemented on a Macintosh computer using HyperCard and Nexpert. ID Expert consists of four subsystems. (1) A content analysis/knowledge acquisition system which acquires the necessary subject matter, student and environment information from the user (designer or subject matter expert). (2) An expert specification system which recommends course organization and transaction strategy appropriate for the content/audience knowledge base acquired from the user. (3) A transaction based development system which enables the user to complete instructional interactions which teach the content acquired by the knowledge acquisition system. (4) A transaction based instructional delivery system which presents the computer based instructional materials to the students.

The operational prototype system will be demonstrated. There will be three brief formal presentations. M. David Merrill will briefly describe the instructional theory underlying the content analysis/knowledge acquisition system and the specification system. Zhongmin Li will briefly describe the implementation of the content analysis/knowledge acquisition system and the specification system. Mark Jones will briefly describe the implementation of the transaction based development system and delivery system.

Formal papers have not been prepared since prototype version 3.0 is currently under development and many changes will occur between now and the convention. This version will be virtually complete by the time of the ADCIS meetings and we will debut ID Expert version 3.0 to ADCIS participants. Documentation describing the system will be distributed at the session.

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# A Student-centered Approach to Computer-assisted Concept Learning

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Two computer-based learning systems employing a student-centered learning model to the task of understanding and differentiating among sets of related concepts are discussed. Unlike traditional CAI in which the author selects an inductive or deductive approach and determines the number of examples and non-examples presented, this model allows students the freedom to move from concept to concept requesting definitions, exemplars, and comparisons among concepts. Students are presented with an "information base" containing an illustration of the relationship among concepts, individual concept definitions, examples and non-examples of each concept, descriptions of how one concept differs from the others, quizzes on each concept, and other features designed by the lessons' authors. By tracking the alternatives students select, the software allows researchers to understand the strategies employed by different subsets of the student population and may result in identification of effective and ineffective strategies for various subgroups.

The first program demonstrated allows students to learn to discriminate among the five "categories of learning outcomes," defined by Gagne & Briggs (1974), and the six "levels of complexity" within the intellectual skills category. Using the second program, students learn to categorize questions teachers ask according to the levels defined in "Bloom's Taxonomy."

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# PRACTICE MODE AND TESTING EFFECTS IN COMPUTER-BASED INSTRUCTION

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The purpose of this study was to investigate the effects of practice mode (recall and recognition) in computer-based instruction on immediate and delayed achievement. A total of 153 seventh grade science students were blocked by sex and randomly assigned to one of two practice modes (recall and recognition) in an instructional program and to both an immediate and delayed test or a delayed-only test condition. After completing the instructional program, subjects were given the choice of topic, practice mode, and delivery medium for a second program.

MANOVA yielded a significant univariate effect indicating that recall practice yielded higher scores than recognition practice on recognition items for subjects who took the delayed test only. A strong time of testing effect revealed that subjects who took the immediate posttest scored significantly higher on the delayed test than subjects who took the delayed test only. The attitudinal data revealed that subjects' choice of topics to study varied significantly depending on whether the instruction for the topic was available on the computer. Subjects reported a strong preference for recognition over recall practice in addition to their preference for computer-delivered instruction.

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# MATCHING COGNITIVE STYLES TO GENERATIVE ACTIVITIES AND CBI/V ATTRIBUTES

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Cognitive styles are stable traits that influence how an individual processes and perceives information. We have identified seventeen such cognitive styles from the literature and have categorized them into nine perceptual and eight processing styles based on whether they deal with the way an individual takes in (perceives) information or organizes it for storage and retrieval (processes). Characteristics of each have then been further defined by their cognitive strengths and weaknesses.

Understanding mental processing, while not a new concept, has been given more serious consideration since the influx of influence of cognitive psychology on the design of instruction. Specifically, information processing and schema theory indicated that deeper processing which ties information into existing structures will enhance retrieval and retard deteriorization of knowledge. From these theories we have identified eight general categories of learning activities by their information processing requirements. Wittrock's (1974) generative model of learning adds an important dimension by proposing that the learner be an active constructor of those mental connections through, for example, the creation of analogies, concept maps, images, paraphrases, etc.

The fact that individuals have both strengths and weaknesses in perception and processing suggests that learning could be enhanced if both the presentation and the processing activities that occur during learning be tailored to their cognitive style. This suggests to us that the mental connections be generated by the individual if the processing requirements of the learning activity employs the individual's cognitive strengths, or be supplanted if it employs an individual's cognitive weaknesses. To do this, the information processing requirements of the various learning activities must also be considered.

The computer medium offers great potential for diagnosing, prescribing, and delivering individualized instruction and for creating an environment for generative learning. In this presentation we will discuss our model which matches cognitive processing styles with either generative or supplanted learning strategies from information processing theory. We will then complete the model by matching the learning activities with computer based and computer based interactive capabilities.

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# EFFECTS OF COMPUTER ANIMATION ON RETRIEVAL TASKS IN SOLVING VELOCITY AND ACCELERATION PROBLEMS

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Recent research has indicated contexts where animation can be used to aid the learning process. Under proper conditions, animation has been found to benefit adults in visualizing science concepts and principles. Computer animation has also been shown to contribute to innovative practice activities involving structured simulations. This presentation will report the results of a recent study which examined the effects of animation as part of presentation, orienting, and practice strategies, on near and far transfer learning with adults. This study extends earlier work by exploring the relationships of structured simulations incorporated into orienting and practice activities for content known to be difficult for the general population. The use of visuals in the testing was also controlled and examined.

A total of 127 college undergraduates participated. The lesson formally introduced the concepts of acceleration and velocity and the principles which govern their relationship. A 2 X 2 X 2 X (2 X 2) mixed factor design was used. Between-subjects factors consisted of Visual Presentation (Static Graphic, Animated Graphic), Orienting Activity (Yes, No), and Practice (Yes, No). Within-subjects factors consisted of Transfer (Near, Far), and Visual Testing Format (Verbal, Verbal/Visual). Dependent measures consisted of posttest performance and response latency on the posttest. Qualitative data in the form of post-lesson questionnaires were also collected.

Results indicated that the orienting and practice activities tended to aid only near transfer learning. The orienting activity may have actually inhibited far transfer learning to a degree. In addition, students who received practice needed less time to answer questions than those who did not receive practice, suggesting that practice aided organization at the time of encoding. As expected, students generally found near transfer questions to be easier than far transfer questions. The use of visuals in the testing had a negative effect on near transfer questions.

Further results and implications will be discussed.

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# Human Factors Implications of Text Display Rates for Computer-Assisted Instruction

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An experiment was conducted to test the effects of varying text display parameters on student performance in a computer-assisted instruction (CAI) course. Seventy-two undergraduate computer science majors took part. Two text display rate treatments were administered: 30 characters per second and 400 characters per second. Two states of help availability were also tested: one in which students had the ability to back up to the previous screen and see the definition of specific terms on the screen, and one in which these features were not available. The experiment attempted to determine whether a fast presentation rate can be a preferable display speed, and whether the increase in human-computer interaction can have a positive effect on student performance. Using a 2x2 factorial design, the CAI course was divided into four lessons. At the completion of each lesson, a multiple choice "practice" (test) was administered to each student. The practice consisted of 20 multiple choice questions evaluating the student's knowledge on that particular section or topic.

Tests on student learning indicated no significant difference in student comprehension between the fast and slow presentation rates and the availability of help. However, 32% of the students preferred the slow presentation rate, 33% of the students preferred the fast presentation rate, and 35% of the students had no preference. The addition of the help facilities in our study did not dramatically effect student performance. Though 68% of the students took advantage of the help facilities, these students did not perform significantly higher on the posttest. Fast display rates did not lead to higher error rates in our study. This is inconsistant with the results previously published by Bevan, Miller, and Tombaugh *et al.* Not only did the students equally prefer the fast and slow presentation rates, but student comprehension was not significantly lower when the fast presentation rate was used. Text display rate does not have an effect on student performance for our target population. If a CAI course is being developed for students identical to our target population, we believe the text can be displayed as quickly as possible,.but that students should be able to vary the display rate themselves.

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# Problem Solving in Higher Education Science and Engineering Assisted by CBI

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In this contribution we report on the results of research into the effectivity of Computer Based Instruction (CBI) for learning the solution of complex exercises in science and engineering courses.
A set of 5 CBI-programs, in which a systematic approach to solving mechanics problems is stimulated, was tested in 6 institutions of higher education in the Netherlands.
In the programs the student is guided to solve the problem by a system of heuristics. The student's steps towards the solution of the problem are supported by feedback.
The aim of the research was to investigate whether this type of CBI-assistance is successful in problem solving exercises in the field of science and engineering. In particular learning results as well as the satisfaction of teachers and students were measured. For the research on the learning results a pre-test post-test control group design was used.
In the presentation we will show the final results of the research and reflect on the design of the CBI-programs and in particular the systematic approach used in the programs.
A paper will be available.

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# CURRENT UNDERSTANDING OF LEARNER CONTROL

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It is intuitively appealing to believe that learner control can improve motivation and achievement but research prior to 1977 did not substantiate this intuition. The major finding was that essentially only learners who are high performers in the subject matter of the lesson sometimes perform better under learner than computer control.

While early studies focused on instructional variables, such as control over the amount of practice or difficulty level, recent research has focused on psychological processes in learning. Empirical studies of learner control during the last decade can be grouped into three broad categories: students' learning strategies (or lack thereof), feedback, and tools or aids to promote or support learners' spontaneous strategies.

A major implication of this research is that the potential benefit of learner control depends on many factors: learner characteristics, lesson goals, the nature of the task, and the intended role of the lesson in the curriculum. For example, learner control of instruction is beneficial if students have appropriate learning strategies for the given subject and know where they should apply them. Feedback about performance enhances the potential benefits of learner control. Adaptive rather than total computer or learner control is a promising new technique.

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# THE EVOLUTION OF AN EXPERT TUTOR FOR JOB SKILLS TRAINING

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Knowledge-based systems offer numerous capabilities which facilitate the use of instructional methods that are impossible or impractical to implement using conventional computer systems. Using this technology, innovative instructional strategies can be implemented in computer-based training systems. These are developed using the combination of a knowledge base which contains rules and facts and an Inference Engine which applies inferential reasoning to the knowledge base to seek and justify a conclusion. These expert training systems can truly individualize instruction based on learner profiles and empirical research on optimum learning activities.

This presentation describes an Expert Tutor (EXT) System developed to train government/military analysts. The system uses a combination of tutorials and expertly guided simulation. This system consists of a rule-based expert shell on a VAXstation II/GPX computer. The presentation describes the development methodology and the lessons learned. The current tutorial and expertly guided simulation capabilities will be described. Future capabilities of EXT will be discussed.

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# Interactive Videodisc Design and Development:

# Lessons from Cognitive Psychology

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Cognitive psychology represents a useful perspective for the designers and developers of interactive instruction. This theoretical stance not only forces us to investigate and evaluate the learners' knowledge state as they enter and undertake instruction, but it also offers specific and practical implications for the design and presentation of that instruction.

This presentation consists of two parts: First, the importance of particular characteristics of the learner's knowledge structures (schemata) will be discussed from both a psychological and instructional perspective. Key findings of cognitive psychology are that learning is active/interactive, and that it proceeds with expectations and a purpose. Furthermore, theory implies that our knowledge structures are modular, i.e., composed of different types and domains; that they are typically bound to a specific context of use or application; and that they are prototypical, that is, they tend to be generic or thematic in nature.

Second, the practical application of these aspects of cognitive theory will be illustrated in the design and development of a Level III interactive videodisc module that teaches a highly-developed medical skill -- the nursing response to a cancer patient with symptoms of infection. Specifically, the usefulness of the notion that knowledge is prototypical or thematic will be illustrated by presentation of one segment of the videodisc program, a prototype case study of nursing practice.

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# Applying Linguistic Analysis to Instructional Design

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The terminology of linguistic discourse is often applied to computer-based instructional situations. We speak of tutorials and dialogues, interface languages and interactions. It is rare to see these terms taken literally, however. The discipline of linguistics has formal description techniques which may allow us to describe the structure of computer-based interaction with greater objectivity. Such devices have been applied to stories (Mandler and Johnson, 1977), classroom discourse(Mehan, 1979), and the cinema (Carroll, 1980).

This paper will be a short tutorial in formal grammar with examples of how it could be used as a research tool for task-analysis, the description of lesson structure, the modeling of interactive dialogue, and perhaps the description of the instructional design process.

As an example of the application of linguistic techniques to ISD consider Gagné's well-known "events of instruction." It is hard to evaluate the theoretical status of the events. How could they be empirically tested? Are all events necessary always? How are they to be related to course-level events, units, lessons, and sub-lessons? Must they be applied in a fixed order? To what extent can the order be transformed? One way of thinking about these problems is to analogize. The events of instruction may be compared to the parts of speech. Sentences are made up of parts just as lessons are. Sentences are infinite in variety but they are constrained structurally. The description of these constraints is a goal of linguistics. Lessons may be thought of as sentences made up from events. The description of the structure of instruction may be thought of as a theoretical goal of instructional design research. This paper will indicate how some of these descriptive problems could be solved using grammatical methodology.

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# The effects of advance organizers and visual metaphors on learning from a hypertext bilingual dictionary

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For this study students were presented with a 120-word Japanese-English hypertext dictionary and given 15 mins to learn as many Japanese words as possible. The dictionary consisted of 24 semantic clusters of five words each. All subjects received a HyperCard stack with identical links and buttons. However, the amount of information available to students was varied between groups. Two crossed between-subjects factors were investigated. The first was the presence or absence of an advance organizer. The second was the presence or absence of a visual metaphor. Dependent measures were recognition and recall of vocabulary. We hypothesized that a lack of information about the semantic hyperspace would cause disorientation which would in turn draw upon limited mental resources, reducing learning. We further hypothesized that the advance organizer would not be effective because the task was rote learning not meaningful learning. Conversely, we thought that visual metaphorical information (in the form of graphics and visual movement effects such as scrolling) would reduce disorientation and facilitate learning. Our data indicated that (contrary to theory) both advance organizers and visual metaphors resulted in increased achievement but that the combination of both types of orienting information caused an interaction resulting in lower achievement in that condition. We speculate that the advance organizer, which was written in literal terms, and the metaphorical graphics induced conflicting mental models which reduced achievement.

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# Rapid Prototyping and Instructional Design

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Computer software design and instructional design are two fields with similar methodologies and purposes. In the past, practitioners in these fields have often followed analogous models in order to create effective, user-friendly materials.

Recently, capitalizing on the increased capabilities of software development tools, software designers have begun to utilize the design method called "rapid prototyping." In this model, after a succinct statement of needs and objectives, research and development are conducted as parallel processes that create prototypes which evolve into a final product.

Suchman's recent research on situated action and Spelke's research on infant cognition suggest changes in cognitive theory that, coupled with modular software development tools like HyperCard, make rapid prototyping a plausible model for instructional design under certain circumstances.

Rapid prototyping would seem to be appropriate in at least the following types of situations: Cases which involve complex factors which make predication problematical, new situations where there is not an abundance of experience upon which to draw, and cases where we have experience but lack satisfaction with results derived from conventional models.

This paper attempts to delineate the theoretical assumptions that take rapid prototyping beyond being only an alternative model of instructional design, and presents the concept as a paradigmatic shift in the manner in which instructional design is contextualized.

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# THE DESIGN AND IMPLEMENTATION OF COGNITIVE LEARNING ENVIRONMENTS FOR THE EMERGING TECHNOLOGIES

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Current research raises significant questions about the adequacy of the delivery model in instruction and posits that problems, exemplars, strategies, and cues may facilitate mental structuring within contextualized learning environments. Conventional instructional practices that equate information delivery with teaching and learner recall with learning assume that a content domain can be abstracted into rules, concepts, and principles and effectively presented without a realistic context. These practices tend to overestimate the importance of cumulative information and underestimate the multidisciplinary character of knowledge, the active role of the learner, and the multifaceted nature of intelligence generally.

Recent computer-based innovations (e.g., hypermedia, CD-ROM, Compact-Disc Interactive, and Digital Video Interactive) possess capabilities that have the potential to support interactive learning environments rich in detail, complexity and realism. The flexible branching capacities, responsive object-oriented interfaces, and remarkable visual characteristics of these technologies can be used to raise the quality of interaction by providing dynamic environments that contain multiple representations of data. These features can accommodate diverse instructional and learning approaches while assisting the learner to construct conceptual knowledge in new domains.

The presentation will explore the important relationships that exist between the content, the context, and the learner's role as knowledge-builder within computer-based learning environments. Discussion will highlight the growing need for field-based research involving the design, development, and implementation of innovative instructional technologies. Current research and new training product trends will be reviewed and implications for education and training curricula utilizing the emerging technologies will be explored.

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# USE OF COMPUTER NETWORKS TO SUPPORT COOPERATIVE VENTURES BETWEEN UNIVERSITIES AND THE PUBLIC SCHOOLS

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Computer networks can be used to support the student teaching process by linking university faculty, student teachers, and supervising teachers in the schools. They can also be used as a tool for school-university collaborations that benefit the schools as well. For example, during Spring 1989 a sixth-grade class at Jackson-Via school in Charlottesville, Virginia, communicated with a corresponding class of native Alaskan children via an inter-university telecommunications network. These interactions were used in support of instructional activities ranging from social studies to mathematics. Similarly, during Fall 1989 a biology teacher at Western Albemarle High School and a doctoral student in the science education program at the University of Virginia used the network to collaborate on development and production of an interactive videodisc simulating dissection of a frog. In another instance, fifth-grade science students at Broadus-Wood school measured the acidity of collected rain samples throughout Spring 1989. This data was transmitted to a central location on a network established by the Technical Education Research Centers for the National Geographic Kids Network project, and pooled with hundreds of other samples from similar schools across the country. Methods used to establish and support telecommunication links between public schools and universities will be discussed in this presentation, and the instructional effects of networked science will be described.

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# THE TECHNIQUES OF TELETRAINING --- NEW ENHANCEMENTS

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Teletraining is a major advance in delivering training to large target populations scattered throughout Army Active Units, the National Guard Units, and Army Reserve Centers. It allows both verbal and visual training, seminar, and conferences over distance, through a system of audio and visual links between specially equipped studios. Now we can deliver training in remote sites where high-tech equipment, skilled instructor, and equipped instructional facilities are not available. In the Department of Defense, videoconferencing is already making a headway, and many organizations are just beginning to set up networks. Army Material Command's (AMC) Video Enhanced Users System (VENUS) network is the first of its kind in operation in DoD, and offers increased flexibility in planning and scheduling meetings and conferences throughout the AMC major subordinate commands, without wasting time, money, and energy on getting people from place to place. Video and audio teletraining provide all the advantages of a face-to-face teaching-learning situation plus on-the-spot, quick, and improved communication link among the distance learning centers.

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# A Computer Bulletin Board System for Teaching the Writing Process: A Pilot Project

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Teaching the writing process in the elementary classroom can sometimes be quite difficult due to the large number of students and the amount of extraneous activity that is often present. Practice by students and individualized tutoring by the teacher are also problematic, since these tasks require large blocks of time and concentrated effort.

Based on the above needs, a computer bulletin board system was designed to help foster the writing process in these students. Using two modems and a long distance telephone line, this system will connect the elementary students with reading methods undergraduates at a nearby university.

Benefits to the elementary students include the availability of a different audience for their writing, personalized feedback from reading methods undergraduates, and the overall encouragement of the writing process. Undergraduate students at the university obtain practice in teaching the writing process to real students as well as a chance to use computer technology in their teaching. The project also allows for an additional use of computers in schools where computer technology may not be used to its full potential.

Future research with the system will include a comprehensive evaluation of student requests for help and an analysis of the type of assistance provided by the undergraduate methods students. Additional use of the system will hopefully lead to a more self-regulating process and increased student participation in its management.

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